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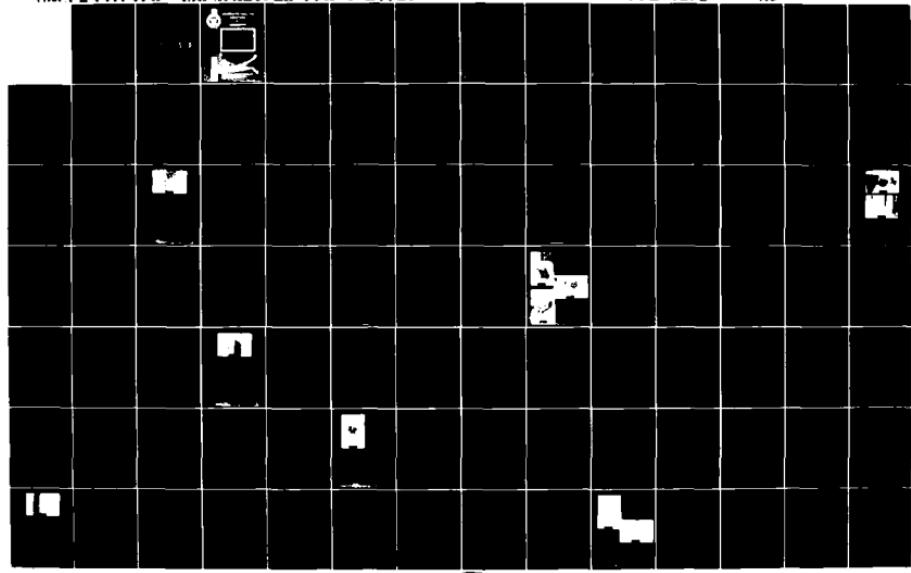
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UNDERWATER FACILITIES INSPECTIONS AND ASSESSMENTS AT
NAVAL STATION CHARLE..(U) NAVAL FACILITIES ENGINEERING
COMMAND WASHINGTON DC CHESAPEAKE.. MAY 81

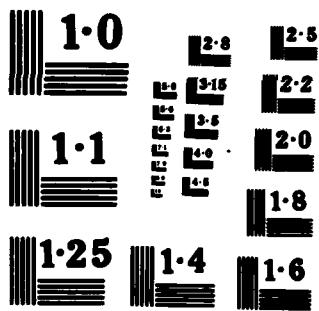
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NAVAL STATION CHARLESTON, SC.**

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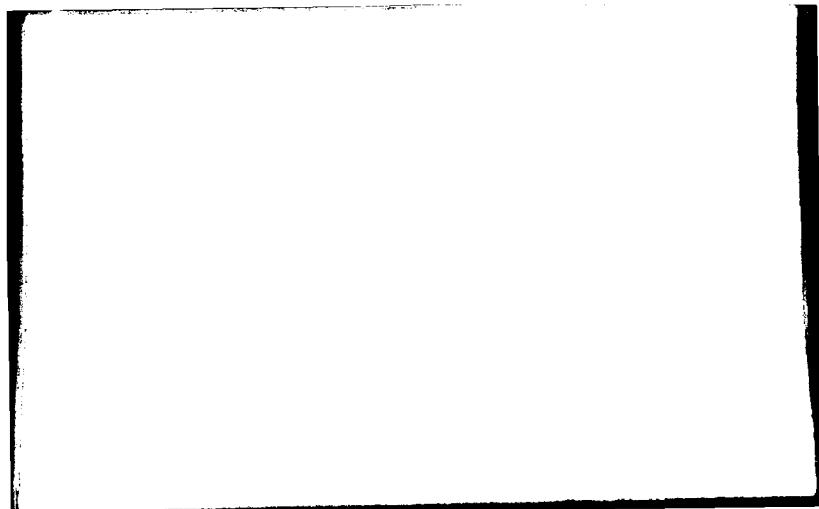
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**UNDERWATER FACILITIES
INSPECTIONS
AND
ASSESSMENTS
AT**

NAVAL STATION

CHARLESTON, SC

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FPO-1-81 (9)

MAY 1981

PERFORMED FOR:

**OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374**

UNDER:

**CONTRACT N62477-80-C-0102
TASK 5**

BY:

**CHILDS ENGINEERING CORPORATION
MEDFIELD, MASSACHUSETTS 02052**

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION AVAILABILITY OF REP. Approved for public release; distribution is unlimited		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			
4. PERFORMING ORGANIZATION REPORT NUMBER	5. MONITORING ORGANIZATION REPORT # FPO-1-81(9)		
6a. NAME OF PERFORM. ORG. Childs Engineering Corp.	6b. OFFICE SYM 7a. NAME OF MONITORING ORGANIZATION Ocean Engineering & Construction Project Office CHESNAVFACENGCOM		
6c. ADDRESS (City, State, and Zip Code) Medfield, MA 02052	7b. ADDRESS (City, State, and Zip) Bldg. 212, Washington Navy Yard Washington, D.C. 20374-2121		
8a. NAME OF FUNDING ORG.	8b. OFFICE SYM 9. PROCUREMENT INSTRUMENT INDENT # N62477-80-C-0102, Task 5		
8c. ADDRESS (City, State & Zip)	10. SOURCE OF FUNDING NUMBERS PROGRAM PROJECT TASK WORK UNIT ELEMENT # # # ACCESS #		
11. TITLE (Including Security Classification) Underwater Facilities Inspection & Assessment at Naval Station Charleston, SC			
12. PERSONAL AUTHOR(S)			
13a. TYPE OF REPORT	13b. TIME COVERED FROM TO	14. DATE OF REP. (YYMMDD)	15. PAGES 81-5 90
16. SUPPLEMENTARY NOTATION			
17. COSATI CODES FIELD GROUP SUB-GROUP	18. SUBJECT TERMS (Continue on reverse if nec.) Underwater inspection, Mooring inspection, Naval Station Charleston, SC		
19. ABSTRACT (Continue on reverse if necessary & identify by block number) The objective of the underwater facility assessments conducted at the U.S. Naval Station in Charleston, South Carolina is to provide a generalized structural condition report of designated facilities within the activity. These facilities are Piers KILO, LIMA, MIKE, NOVEMBER, PAPA, QUEBEC. (Con't)			
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT SAME AS RPT.	21. ABSTRACT SECURITY CLASSIFICATION		
22a. NAME OF RESPONSIBLE INDIVIDUAL Jacqueline B. Riley	22b. TELEPHONE 22c. OFFICE SYMBOL 202-433-3881		
DD FORM 1473, 84MAR			
SECURITY CLASSIFICATION OF THIS PAGE			

BLOCK 19 (Con't)

ROMEO, SIERRA, TANGO and UNIFORM. Each facility was inspected by a team of engineer/divers using a combination of visual/tactile and ultrasonic techniques. Critical elements were photo-documented.

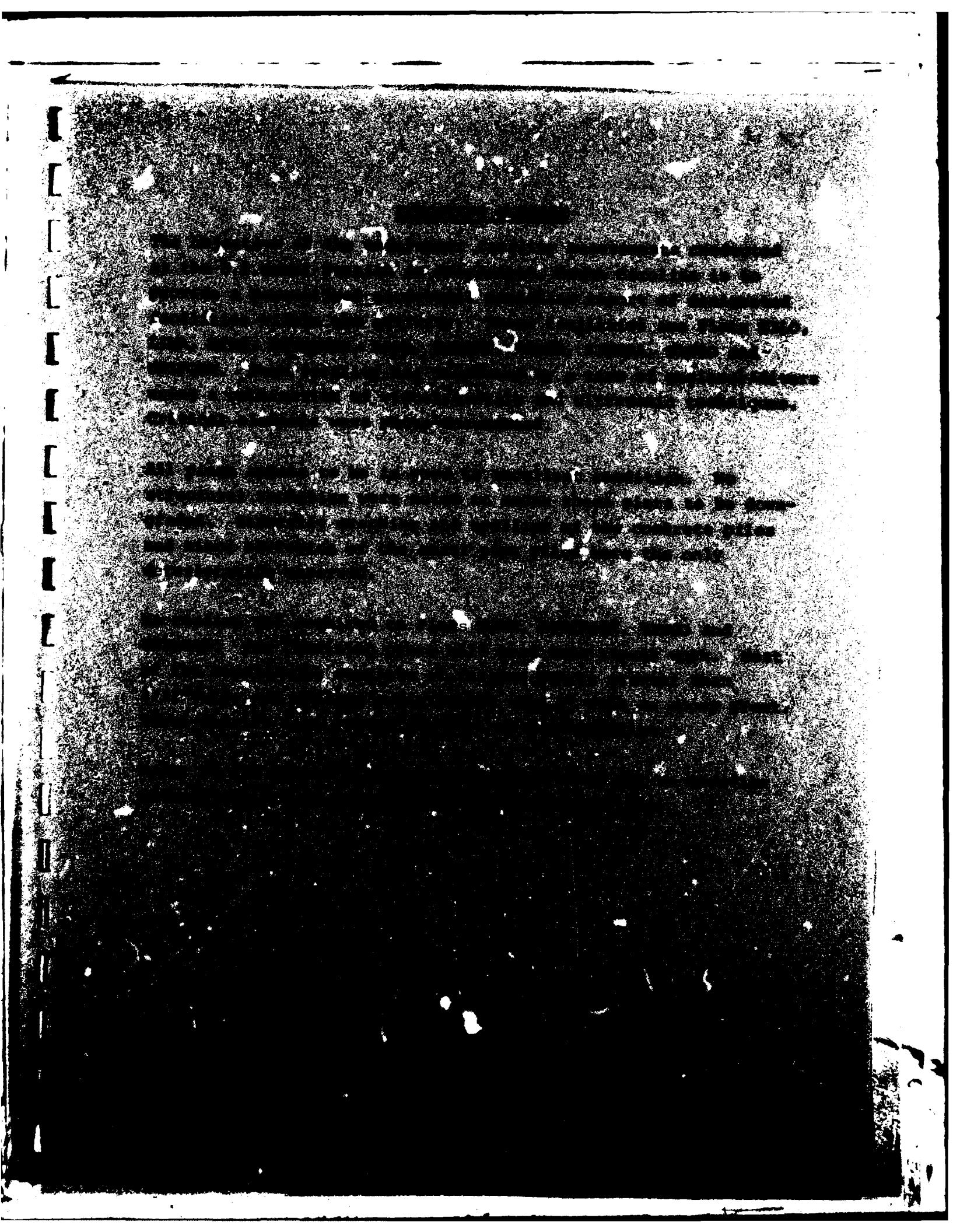
All piers appear to be in good to excellent condition. No structural anomalies were noted to cause these piers to be downgraded. Generally cracking and spalling of the concrete piles and minor corrosion of the steel pipe piles were the only deterioration observed.

No repairs are required on Piers MIKE, NOVEMBER, TANGO and UNIFORM. The remaining piers will need some repair work. Most of the repair work consists of filling cracks greater than 1/32" wide and spalled areas deeper than 1" with an epoxy grout. These repairs will retard any further deterioration.

FOREWORD

The scope of the inspection at the Naval Station in Charleston, South Carolina and the detail to which it was performed and reported was tailored specifically to the conditions at this facility. The report or the procedure associated with its formation is not intended to be a standard for inspections or reports covering other activities. Attempts are being made, however, toward establishing standards for procedures and formats for inspection and assessment reports. Through these standards, inspections performed by different persons, on many facilities and under a wide range of conditions can be effectively compared. It is expected that the inspections and assessments of the Naval Station facilities, like previous operations mandated under the underwater portion of the Specialized Inspection Program, will contribute significantly toward achieving that objective.

It should be noted that the choice of the level of inspection and the procedural detail to be employed will be an engineering judgement made separately for each activity/facility to suit its unique situation and needs. Accordingly, the procedures used at the Naval Station, rather than serve as a detailed model for inspections elsewhere, will provide guidance with general applicability to future inspections.



NAVAL STATION

CHARLESTON, SOUTH CAROLINA

EXECUTIVE SUMMARY TABLE

<u>Facility</u>	<u>Year Built or Modified</u>	<u>No. of Vertical Bearing Piles</u>	<u>No. of Batter Piles</u>	<u>Facility Size</u>	<u>Structure</u>
Pier KILO	Built 1946; Modified 1975	88	144	917' long x 30' wide	18" square pre reinforced con piles
Pier LIMA	Built 1946	92	144	957' long x 30' wide	18" square pre reinforced con piles
Pier MIKE	Rebuilt 1975	297	234	Approach Pier: 600' long x 70' wide; Finger Pier: 500' long x 25' wide	18" square pre reinforced con piles
Pier NOVEMBER	Built 1946; Rebuilt 1964, 1976	257	250	1157' long x 60' wide	18" square pre reinforced con piles
Pier PAPA	Built 1946; Rebuilt 1963	288	308	1357' long x 60' wide	18" square pre reinforced con piles
Pier QUEBEC	Built 1946; Rebuilt 1965	222	248	1036' long x 60' wide	18" square pre reinforced con piles
Pier ROMEO	Built 1946; Rebuilt 1970	64	112	677' long x 30' wide	18" square pre reinforced con piles
Pier SIERRA	Built 1956	48	63	521' long x 31' wide	12" diameter ste pipe piles and 18" square pre reinforced con pile
Pier TANGO	Built 1956	48	62	521' long x 31' wide	12" diameter ste pipe piles
Pier UNIFORM	Built 1956	48	62	521' long x 31' wide	12" diameter ste pipe piles

NAVAL STATION

CHARLESTON, SOUTH CAROLINA

EXECUTIVE SUMMARY TABLE

<u>Facility Size</u>	<u>Structure</u>	<u>Recommendations</u>	<u>Est. Cost of Recommendations</u>
917'long x 30'wide	18"square precast, reinforced concrete piles	1) Repair cracks greater than 1/32"wide with epoxy grout 2) Replace deteriorated concrete encasements	\$40,000 \$21,500
957'long x 30'wide	18"square precast, reinforced concrete piles	1) Repair cracks greater than 1/32"wide and spalled areas deeper than 1"with an epoxy grout 2) Repair the two damaged piles	\$45,000 \$ 1,300 - \$10,000
Approach Pier: 600' long x 70' wide; Finger Pier: 500' long x 25' wide	18"square precast, reinforced concrete piles	No repairs are necessary	N/A
1157'long x 60'wide	18"square precast, reinforced concrete piles	No repairs are necessary	N/A
1357'long x 60'wide	18"square precast, reinforced concrete piles	1) Repair cracks greater than 1/32"wide and spalled areas deeper than 1"with an epoxy grout	\$51,000
1036'long x 60'wide	18"square precast, reinforced concrete piles	1) Repair cracks greater than 1/32"wide and spalled areas deeper than 1"with an epoxy grout	\$58,000
677'long x 30'wide	18"square precast, reinforced concrete piles	1) Repair cracks greater than 1/32"wide and spalled areas deeper than 1"with an epoxy grout	\$36,000
521'long x 31'wide	12"diameter steel pipe piles and one 18"square precast, reinforced concrete pile	1) Repair crack in concrete jacket	\$ 500
521'long x 31'wide	12"diameter steel pipe piles	No repairs are necessary	N/A
521'long x 31'wide	12"diameter steel pipe piles	No repairs are necessary	N/A

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SECTION 1

INTRODUCTION

This report is a product of the Underwater Inspection Program conducted by the Ocean Engineering and Construction Project Office (FPO-1), Chesapeake Division, Naval Facilities Engineering Command (NAVFACENGCOM) under NAVFAC's Specialized Inspection Program.

Mandated under Contract No. N62477-80-C-0102, this program sponsors task-oriented engineering services for the inspection, analysis and design and monitoring of repairs for the submerged portions of selected Naval Waterfront Facilities. All services required to produce this report were provided by Childs Engineering Corporation of Medfield, Massachusetts under Task No. 5 of the Underwater Inspection Program.

The efforts expended and costs required to perform these underwater facility inspections vary greatly with the size, age, kind and construction type of the facilities involved. Other factors peculiar to a particular facility or activity also have an important effect on inspection time and costs. These factors include:

- *Type and quantity of biofouling to be cleaned for different levels of scrutiny, both visual and with instruments;
- *Tidal range - area exposed at low tide for boat inspection;
- *Time and type of last inspection;
- *Local environmental factors - salinity, pollution level, temperature, etc., affecting rates of corrosion and marine life;
- *Function of the facility and the level of activity associated with that function.

1.1 TASK DESCRIPTION

The scope of work for this portion of the program required the inspection of the underwater portion of designated piers located at the Naval Station in the Charleston Naval Complex

in South Carolina. The quality of inspection had to be sufficient to provide an adequate general structural assessment of the facilities and to identify areas of sufficient damage and/or deterioration to warrant immediate repair or a future, more detailed investigation.

1.2 REPORT CONTENT

The report contains a description of inspection procedures, the results of the inspection and analysis of the findings, accompanied by pertinent drawings and photographs. Specifically, the inspection results include a description of the location, construction and function of each facility examined within the Naval Station, its observed condition and a structural assessment of that condition. Recommendations for each facility, including cost estimates for any repair work, are also included. Structural assessment calculations and cost estimate breakdowns can be found in the Appendix. Also, as supplementary information, a brief description of the Naval Station is provided to define its location, mission, history, existing facilities, climate, and hydrographic and topographic features.

<u>SECTION 2</u>	<u>ACTIVITY DESCRIPTION</u>
------------------	-----------------------------

This section provides a general description of the Naval Station, which is one of eight commands within the Charleston Naval Complex in South Carolina. The description includes brief discussions of the Naval Station's location, mission, history, existing facilities, climate, topography and hydrology. This information provides a more overall view of the activity and a perspective to accurately assess the structural conditions of the facilities inspected.

2.1 LOCATION OF ACTIVITY

The Naval Station is located on the Atlantic seaboard approximately 10 miles north of the city of Charleston, South Carolina, in Charleston County. It is contained within the Naval Base South area of the Naval Complex and covers 1,150 acres. The Station lies on the west bank of the Cooper River, beginning approximately 10 miles upriver from the mouth of Charleston Harbor and continuing upstream for about 2 miles (see Figure 1).

2.2 MISSION OF ACTIVITY

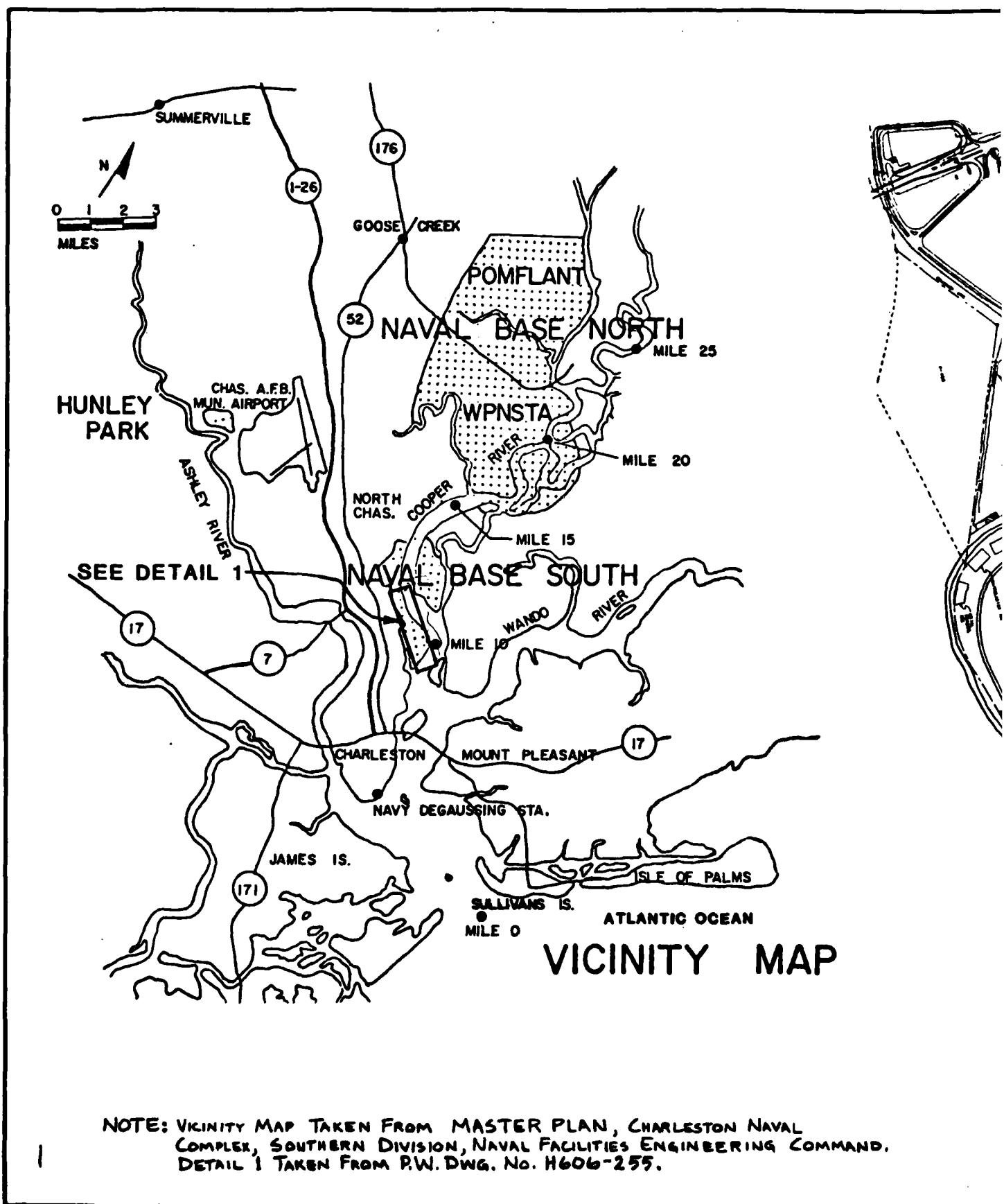
"The mission of Naval Station Charleston is: To provide, as appropriate, logistic support for the operating forces of the Navy, and for dependent activities and other commands as assigned. Some of the services provided are:

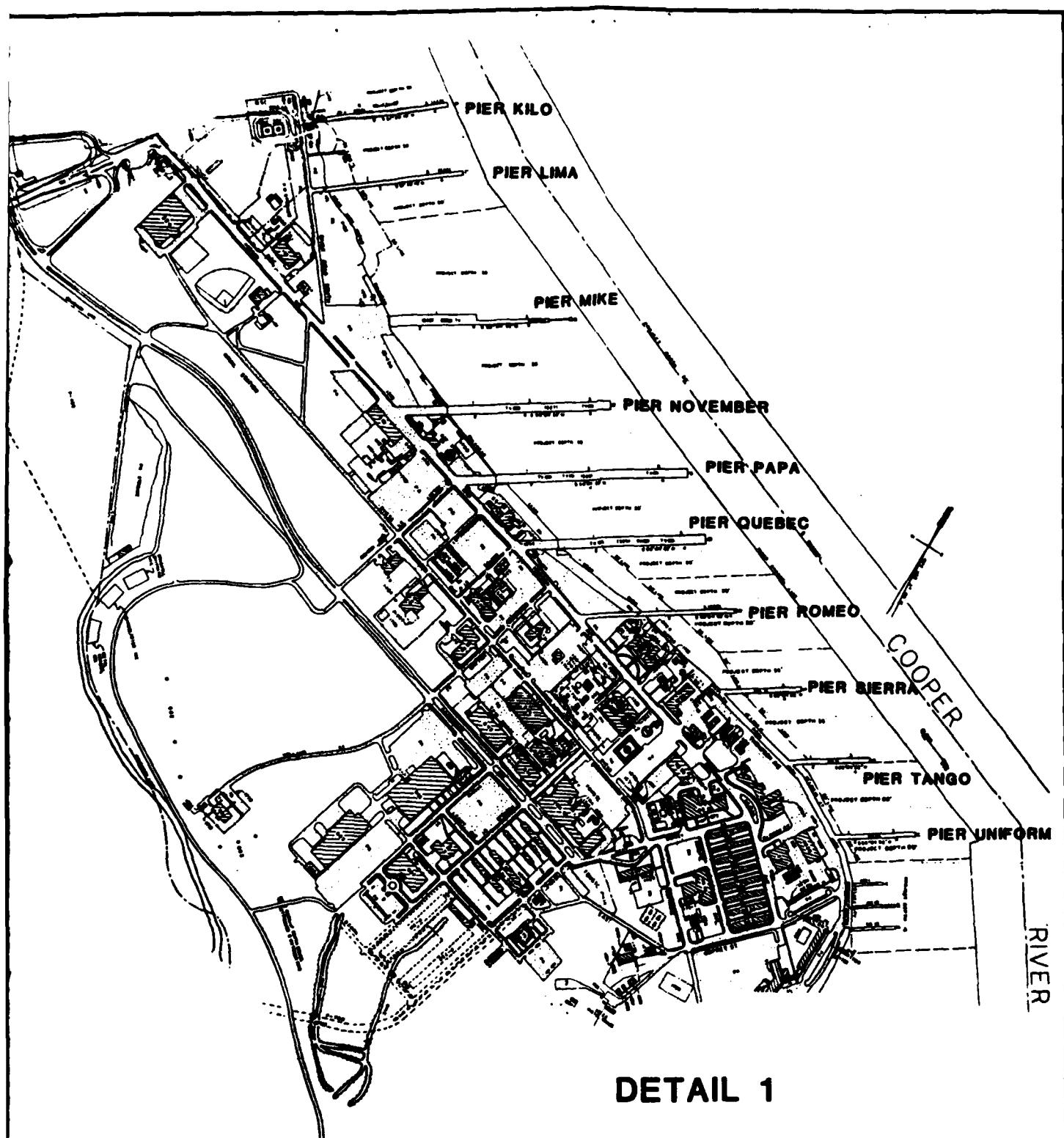
Port services, including berthing, tugs, pilots, cranes, fueling, literage, sludge removal for pollution control, and ammunition handling services. Twenty boats are assigned to this department, and ¹pilots are involved in about 4,000 ship movements annually."

2.3 HISTORY OF ACTIVITY

"The [Charleston Naval] Complex originated in 1901 when a Base was established at Charleston as successor to a small fleet repair base at Port Royal, South Carolina.

In 1918, the Headquarters 6ND was moved from downtown Charleston to the Base, where it has remained except for several years during World War II."²





DETAIL 1

GRAPHIC SCALE	CH2M Engineering Corporation Box 233, Boston, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL STATION CHARLESTON, SC	PL. NO.
2 N/A		LOCATION PLAN	1

"In 1958, new buildings and piers were completed at the south end of the Base to accommodate ships and personnel of active Atlantic Fleet units."

The Naval Station was established in July 1959 as one of the major elements of the Base.

"The Complex is the largest shore establishment in the Sixth Naval District. It has much in common with other naval bases, but has activities not duplicated elsewhere. The Complex continues to expand with an orientation toward service to the modern Navy and the Trident Submarine fleet."⁴

2.4 EXISTING FACILITIES

"Naval Station has ten stationary piers and three floating piers. These piers can accommodate up to forty ships...."⁵

"Piers LIMA through UNIFORM provide berthing for the larger ships, such as submarine tenders (AS), nuclear submarines (SSN), destroyers (DD), frigates (FF), guided missile equipped cruisers (CG), destroyer tenders (AD), mine sweepers (MSO), and special purpose ships (AG). Floating Piers VICTOR, WHISKEY and X-RAY were built to berth the smaller mine sweepers (MSB), but they are of limited value in supporting current requirements at Naval Station.

Pier YANKEE is used exclusively for degaussing and is located in an area of relative quiet from an electrical and magnetic standpoint."⁶

Another stationary pier, Pier KILO, is included in this report as part of the Naval Station's facilities, but is actually the Naval Supply Center's fuel pier. It can accommodate both tankers and fuel barges (see Figure 1).

2.5 CLIMATE

"In general the climate of the area is temperate, modified considerably by the nearness of the ocean. Monthly wind speeds average 9 mph with wind directions varying with the season. The area is subject to occasional hurricanes between July and September.

The area experiences no dry seasons although nearly 41% of the 49 inches of average annual precipitation occurs during the summer months. Thunderstorms are most frequent during the summer."

Mean monthly precipitation ranges from a low of 2 inches to a high of 7.5 inches. Relative humidity ranges from an annual low of 57% to a high of 87%. Average annual sunshine is about 64% of maximum.

The annual temperature ranges from 55° to 75° F. with a mean of 62° F. Summer temperatures (June to August) range from 70° to 90° F. with an average of 80° F., while winter temperatures (December to January) range from 37° to 57° F. with an average of 47° F.

2.6 TOPOGRAPHY AND HYDROLOGY

"The Charleston Navy Complex is located in an area of very level topography. The maximum elevation of this area is approximately 35 feet above mean sea level. This level topography along with the rainy, humid climate of the region, produces many slow draining areas. Naval Base South tends to be swampy with little relief; on the other hand, Naval Base North has an abundance of fresh water ponds and extensive forests."⁸ Ground water is found from 2 to 18 feet beneath the surface.

"The basic flood used for Navy planning is the 100 Year Flood. This identifies an elevation that rising water is expected to reach once in every 100 years. The 100 year flood plain for the Charleston area is 10 feet above mean sea level. All buildings containing materials dangerous to the public, residential buildings, and buildings needing a high degree of protection must be sited above the 100 year flood plain."⁹

Almost all the land within Naval Base South lies below the 100 year flood plain, making it nearly impossible to comply with this siting restriction. However, Naval Base North contains considerable usable area above the 100 year flood plain.

Although the Naval Station is located between 10 and 12 miles upstream from the mouth of Charleston Harbor, it is tidally influenced and is marine in character. Tidal ranges for the Naval Station are as follows:

	<u>Feet</u>
MEAN LOW WATER	0.0
MEAN TIDE LEVEL	2.6
MEAN TIDE RANGE	5.2
SPRING TIDE RANGE	6.1

The Naval Station requires regular dredging to remove the considerable amount of silt deposited by the river. The river channel is maintained at a depth of 35 feet below mean low water.

SECTION 3

INSPECTION PROCEDURE

Between March 31 and April 15, 1981, a team of one engineer and two technicians, all certified SCUBA divers, performed an on-site underwater inspection of selected piers at the Naval Station, Charleston, South Carolina. The level of inspection to be performed, the type of structure being inspected, actual on-site conditions and past experience, combined with a thorough knowledge of engineering theory, dictated the inspection procedures that were followed.

3.1 LEVEL OF INSPECTION

The inspection techniques used had to be sufficient to yield information necessary to make a general condition assessment of the supporting structure of each facility, identify any areas that were mechanically damaged or in advanced states of deterioration, and formulate repair and maintenance recommendations and cost estimates. In general, this meant utilizing visual/tactile inspection techniques, accompanied by occasional external measurements employing such instruments as a scale, calipers or ultrasonic steel thickness gauge, where appropriate. Photographic documentation of typical as well as notable or unusual conditions was also obtained.

3.2 INSPECTION PROCEDURE

The scope of work for Task No. 5 of the Underwater Inspection Program required that ten stationary piers at the Naval Station be inspected from the splash zone (practically speaking, the pile cap) to the mudline for general conditions and any gross structural damage or deterioration. The fender and utility systems were beyond the scope of this inspection.

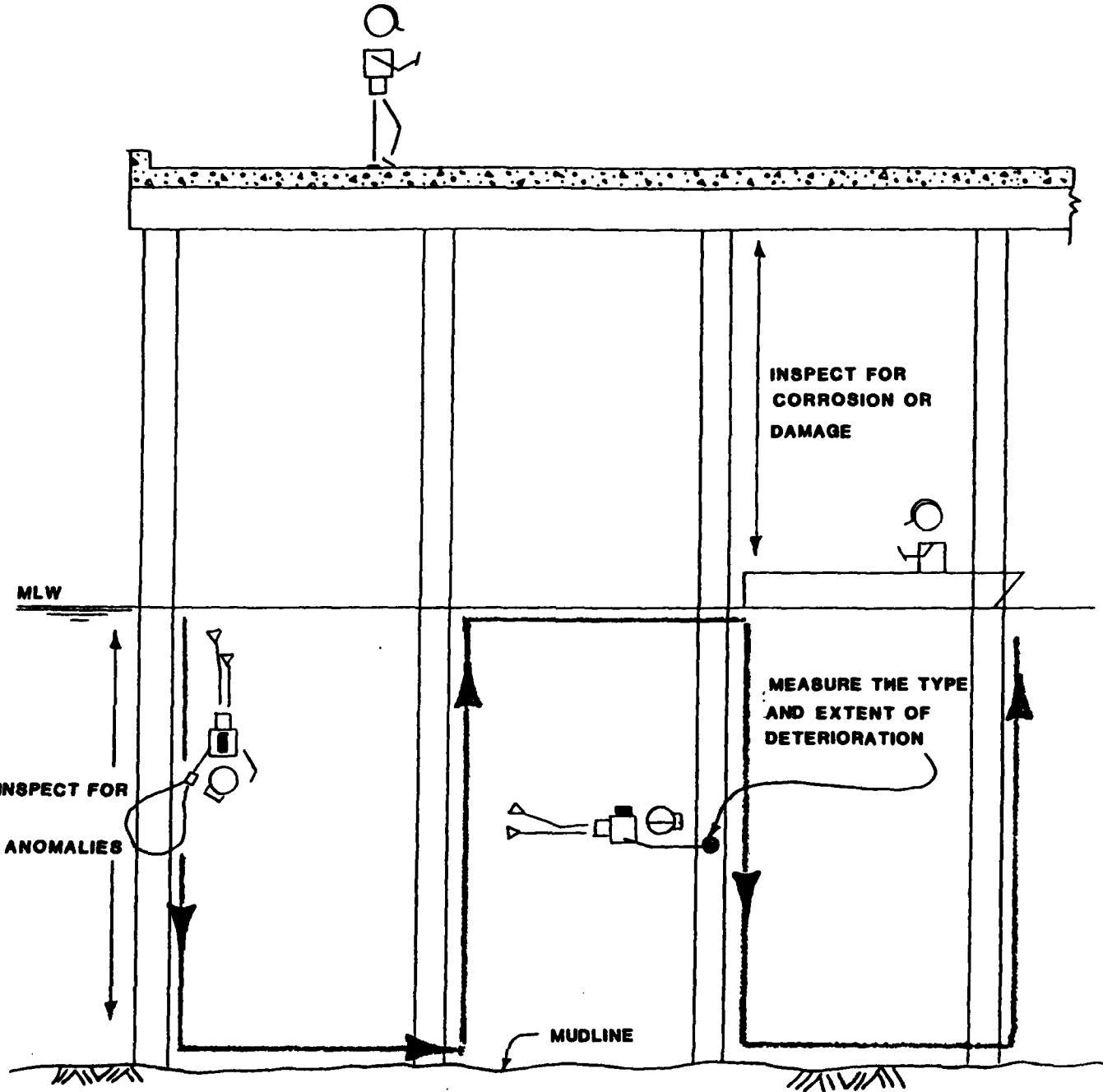
A dive team consisting of two divers and one tender/notekeeper performed the on-site inspection. Past experience has proven this arrangement to be efficient as well as safe. Depending

on the layout of the piles, divers would either inspect alternate bents or each take a portion of a bent. A minimum of 20% of the piles of each facility were closely inspected from the pile cap to mudline. The remainder of the piles were given a more cursory "swim-by" inspection, normally at mean low water as much of the damage or deterioration was seen in this area. Usually, every fifth bent was inspected closely in a manner similar to that depicted in Figure 2. Soundings were taken at intervals around the perimeter of each facility.

Often it was necessary to remove marine growth and/or corrosion from some surface areas of selected piles for an adequate structural assessment. Small patches were frequently cleared during a close inspection. If the piles were steel, ultrasonic thickness readings were taken in the cleaned area.

For facilities with reinforced concrete piles, inspection involved the noting of any cracking, spalling or rusting. Piles were hit with a hammer to gauge the soundness of the concrete and any softness that might be present.

For facilities with exposed steel piles, corrosion of the metal was an important concern. Based on classical corrosion curves, as shown in Figure 3, areas of maximum corrosion usually occur at or around mean low water (MLW), within 2 feet of the mudline, in the splash zone and in areas where a differential oxygen concentration cell is set up. This latter case can occur at the interface or boundary areas between concrete and steel. As a result, the steel adjacent to the concrete is sacrificed to protect the steel under the concrete.



TYPICAL DIVER INSPECTION PATH

GRAPHIC SCALE

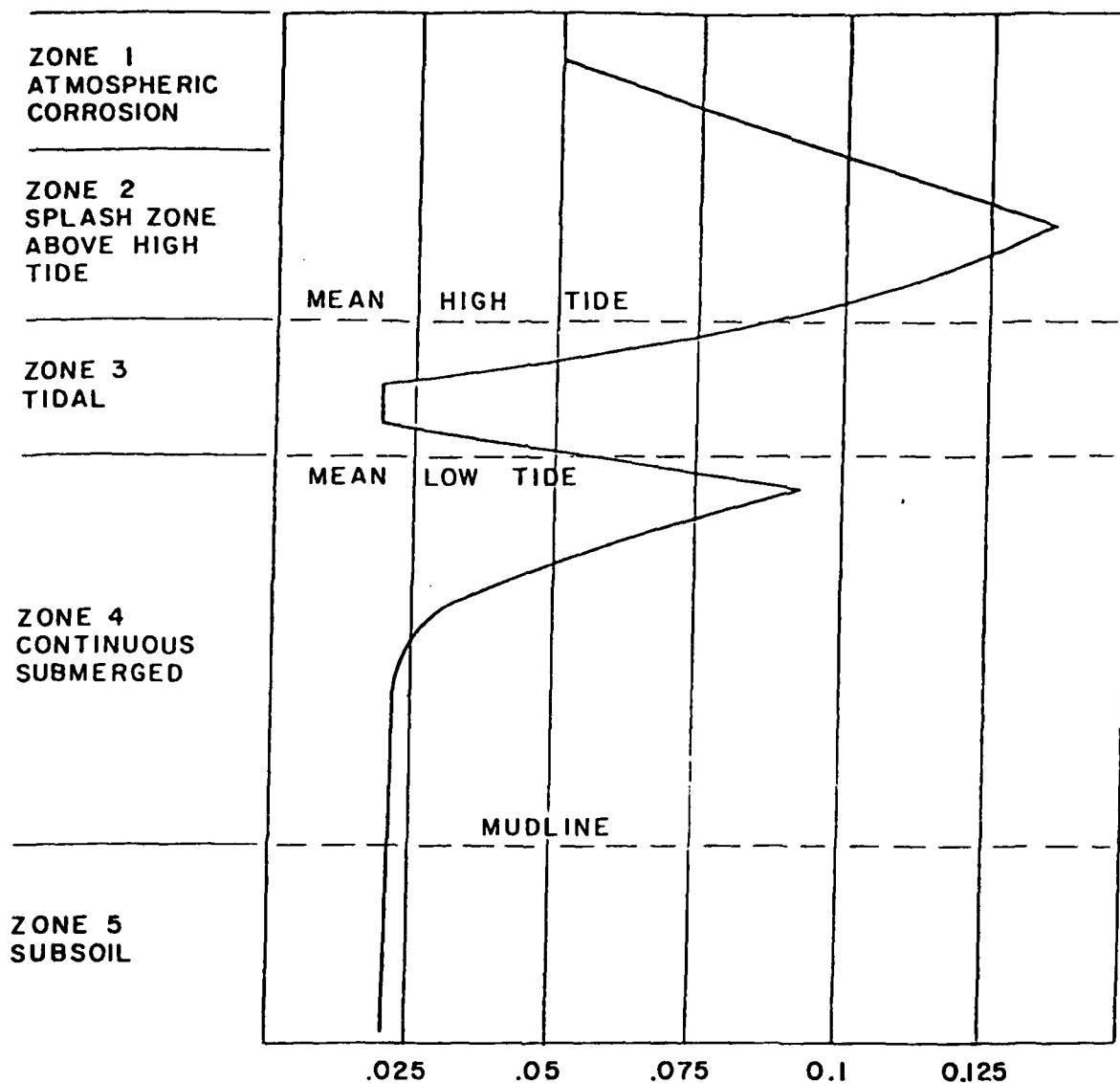
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CHESTNUT DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

NAVAL STATION CHARLESTON, SC

PB NO. 2



RELATIVE LOSS IN METAL THICKNESS CORROSION PROFILE OF STEEL PILING - FIVE YEARS EXPOSURE IN SEAWATER

FROM: S. C. FYRE, "THE PROTECTION OF PILING" IN DESIGN AND INSTALLATION OF PILE FOUNDATIONS AND CELLULAR STRUCTURES, ED., HSIAI-YOUNG FANG AND THOMAS D. DISMUKE (PENNSYLVANIA: ENVO PUBLISHING CO., INC 1970) PP 191-207.

GRAPHIC SCALE	N/A	COURTESY OF US CORROSION PROFILE FOR STEEL PILES
Childs Engineering Corporation Box 325 Anacostia, DC	NAVAL STATION WALTON, NC	NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PAGE NO. 3

To document the corrosive activity, corrosion profiles were taken on selected piles. Small areas of the pile were cleaned to bare metal at selected elevations, and metal thickness was measured with an ultrasonic thickness gauge and/or calipers. The number of readings taken per pile and the number of piles measured per facility were based on profiles previously obtained and on experience.

It should be noted that during our investigation no destructive testing was performed. The conditions noted reflect direct observation or measurement of structural components which were accessible. Information which may infer knowledge of conditions of hidden components are based on government-furnished documents, our knowledge of structures in similar environments and/or generally accepted engineering theories.

3.3 INSPECTION EQUIPMENT

Equipment used for the inspection included a Krautkramer D-meter ultrasonic steel thickness gauge with DMR probe and 75 feet of cable, a Minolta SRT 200 camera with 28mm and 50mm lenses and strobe, a Nikonos III underwater camera with Nikon closeup lens and 7" x 9" stainless steel framer, water box (for use in low visibility conditions) and strobe, dive lights, 100-foot sounding tape, 50-foot cloth tape, 6-foot folding rule, calipers, chipping hammers and dive knives.

Choice of equipment was made as a result of past experience. Most of the equipment is straightforward, easy to handle, carry and use, and has proven reliable under hard use.

Ultrasonic steel thickness gauging is preferred over other techniques (such as drilling test holes) since it is non-destructive, easy to handle, fast and reasonably accurate.

SECTION 4FACILITIES INSPECTED

Within this section of the report, each facility inspected at the Naval Station is referenced separately. The discussion of each facility is presented in four parts: 1) a description of the construction and function of the structure, which is derived both from the on-site inspection and from the referenced government-furnished drawings; 2) an enumeration of general and specific conditions observed during the on-site inspection; 3) a qualitative assessment of the structural condition of the facility based on the inspection data; and 4) recommendations for actions to be taken to insure long-term, cost-effective maintenance and utilization of the facility. Detailed breakdowns of cost estimates are included in the Appendix.

Marine growth profiles were noted for each facility. These profiles were similar for all the facilities at the Naval Station. In general, oysters, mussels and barnacles, along with a mat of hairlike growth covered both steel and concrete piles from mean low water to mudline (see Photo #1). Growth often thinned out within 6" - 12" of mudline, probably due to scouring. Oysters and the hairlike mat could be up to 4" - 5" thick in places, but averaged in thickness from 1" - 3". Growth thinned out above mean low water to sporadic clumps of small oysters and mussels and a scattering of barnacles, all of which ended in the splash zone. Figure 4 illustrates the general growth pattern.

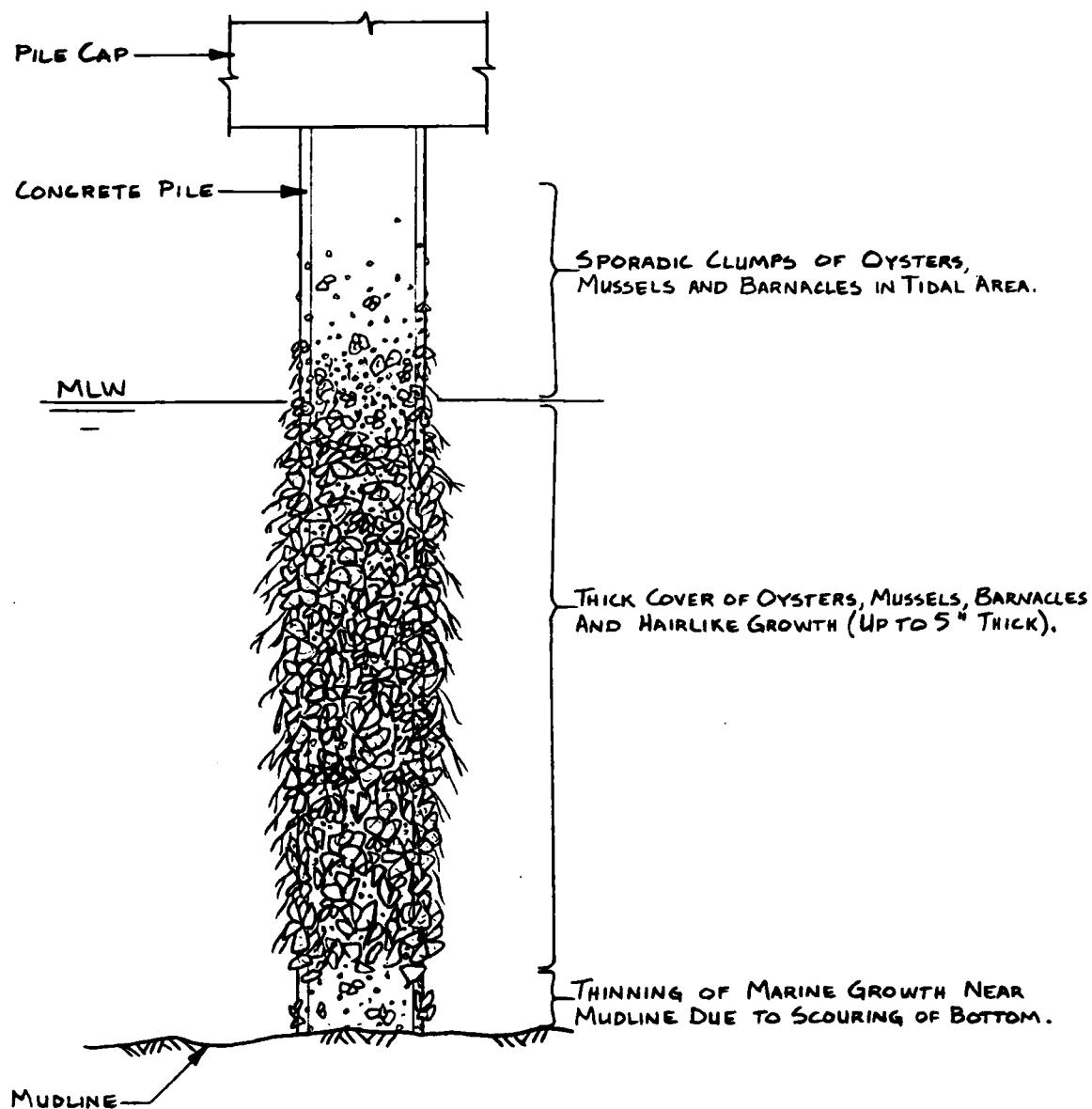
On the facilities with steel piles (Piers SIERRA, TANGO and UNIFORM), deposits of black corrosion by-product with gas pockets trapped beneath were not uncommon. This corrosion buildup was not heavy, usually less than 1/4" thick. Patches of orange oxidation were also seen, usually just beneath the concrete jacket. Both types of corrosion are illustrated in Figure 5.

PHOTO #1: Example of Marine Growth Observed
at the Naval Station Around Mean
Low Water (Pier SIERRA)

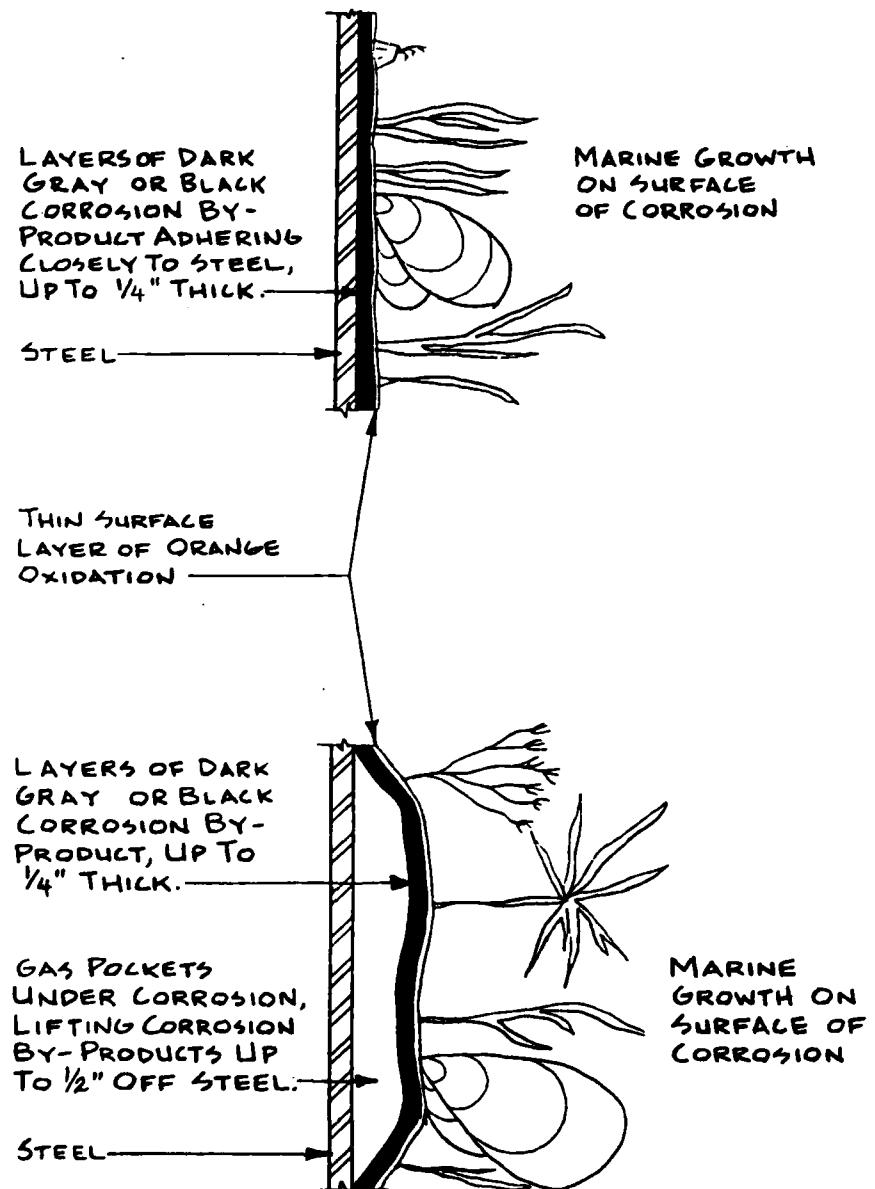


PHOTO #1





GRAPHIC SCALE	Childs Engineering Corporation Box 338 - Somerville, MA	CHEMPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL STATION CHARLESTON, SC
NOT TO SCALE		MARINE GROWTH PROFILE



GRAPHIC SCALE	Childs Engineering Corporation Box 333 - Boston, MA	CHEMPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.
N/A		NAVAL STATION <small>CHARLESTON, SC</small> TYPICAL CORROSION BUILDUP FIG. NO. 5

The terms "cosmetic spalling" and "softness" are frequently used in this section. Cosmetic spalling is used to indicate surface spalling of concrete that does not affect the structural integrity of the structure. The term "softness" indicates that the concrete has been permeated by water. This is a sign of deterioration, the seriousness of which must be evaluated in each instance. Since softness is often associated with spalling and/or cracking of the concrete, it is usually considered in conjunction with these other conditions.

4.1 PIER KILO

4.1.1 Description

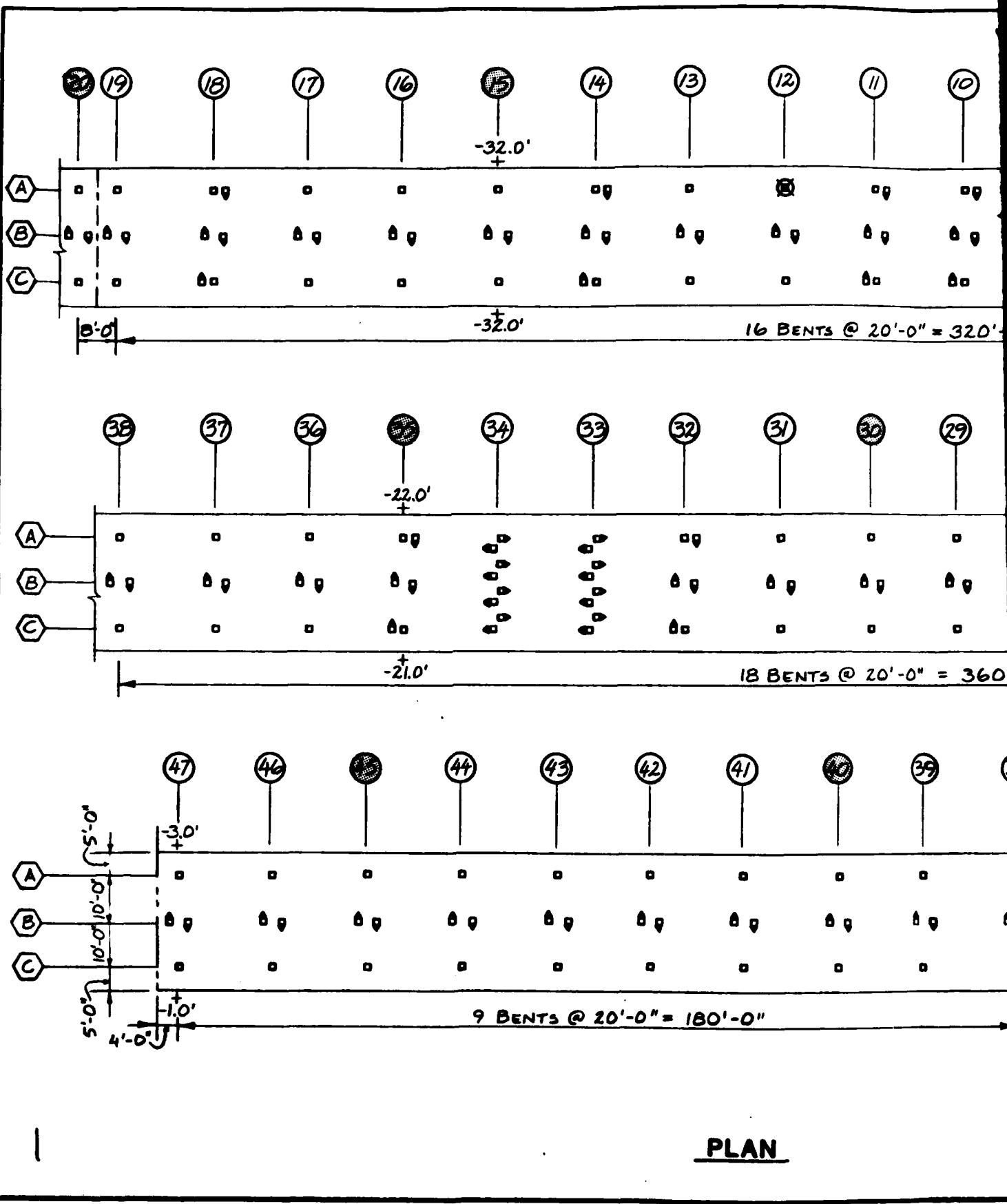
Pier KILO is situated on the west bank of the Cooper River just south of Pier JULIET in the Naval Shipyard and just north of Pier LIMA in the Naval Station. It functions as the Naval Supply Center's fuel pier and can handle both tankers and fuel barges.

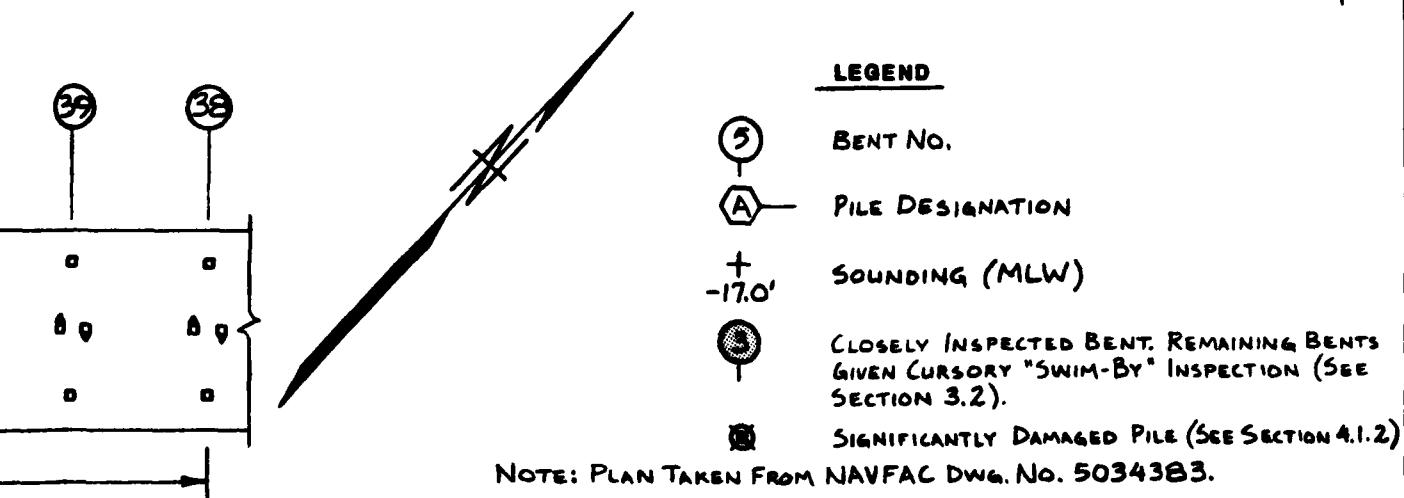
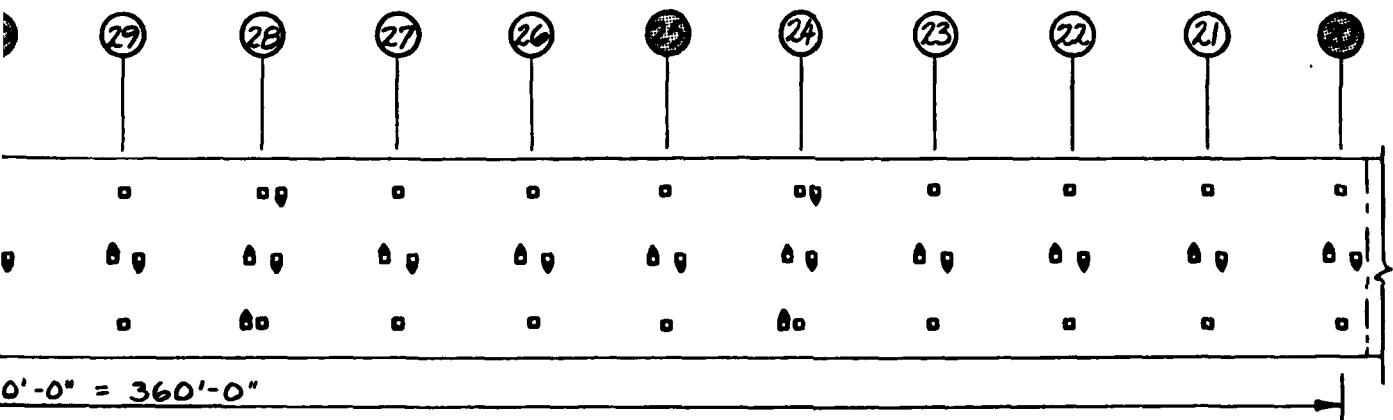
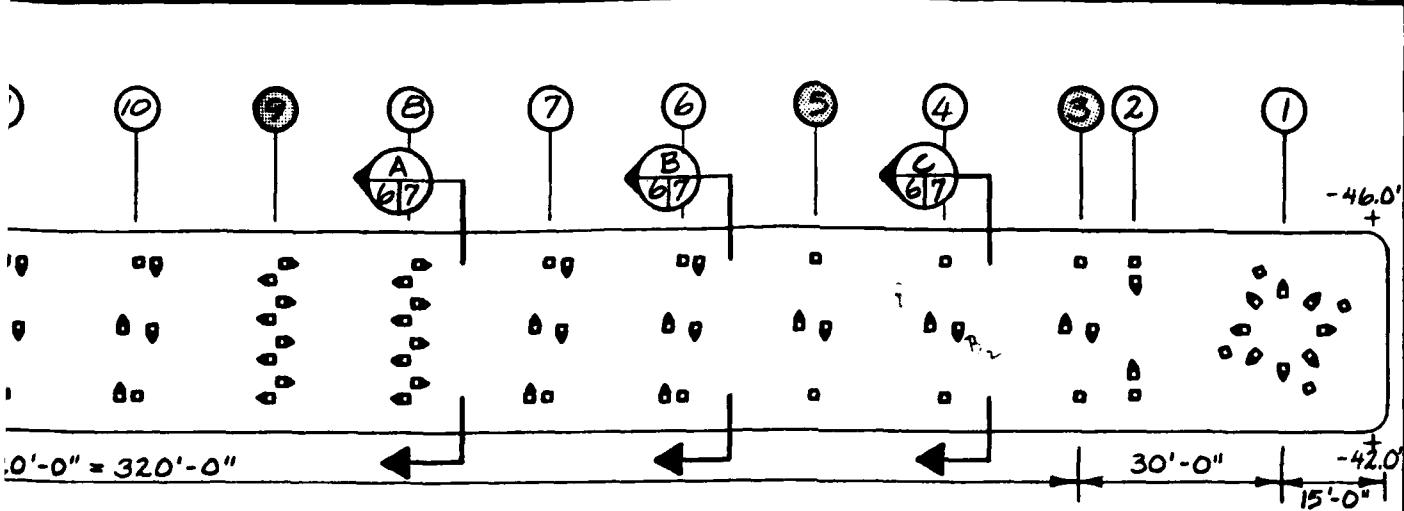
Pier KILO was built around 1946, repaired in 1973 and modified in its conversion to a fuel pier in 1975. The 917' long x 30' wide pier is supported by newer (1975) 18" square precast, prestressed concrete piles (Bents 1 and 2) and older 18" square precast, reinforced concrete piles (perhaps 1946; see Figure 6). Twenty-eight percent of the older piles had been repaired with a concrete encasement from or near the pile cap down a variable distance, up to 26 feet long in some cases. Seventy-eight percent of these jackets were 34" diameter cylinders and 22% were 30" square in form. The reinforced concrete deck is supported by 47 bents with a total of 144 batter piles and 88 vertical bearing piles (see Figure 7). In 1946, the pier design called for a minimum bearing capacity of 50 tons for the piling and a deck live load of 300 PSF uniform load or H-15 loading plus 15% impact.

References: Naval Shipyard, Charleston, S.C.
"Facilities for Inactive Vessels - Piers
Nos. 1 to 6"
Y&D Dwg. #395,722 and #426,219

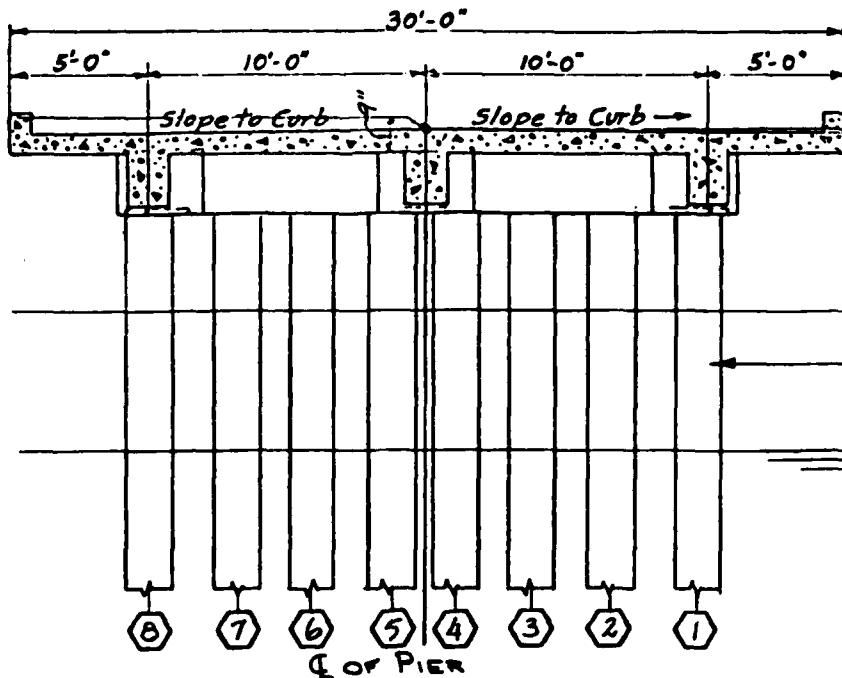
Naval Station, Charleston, S.C.
"Pier K (325) - Repairs of Bearing Piles"
P.W. Dwg. #H325-61

Southern Division, Naval Facilities Engineering Command
"Convert Pier KILO to Fuel Pier - Structural -
Pier K - Pile Plan"
NAVFAC Dwg. #5034383



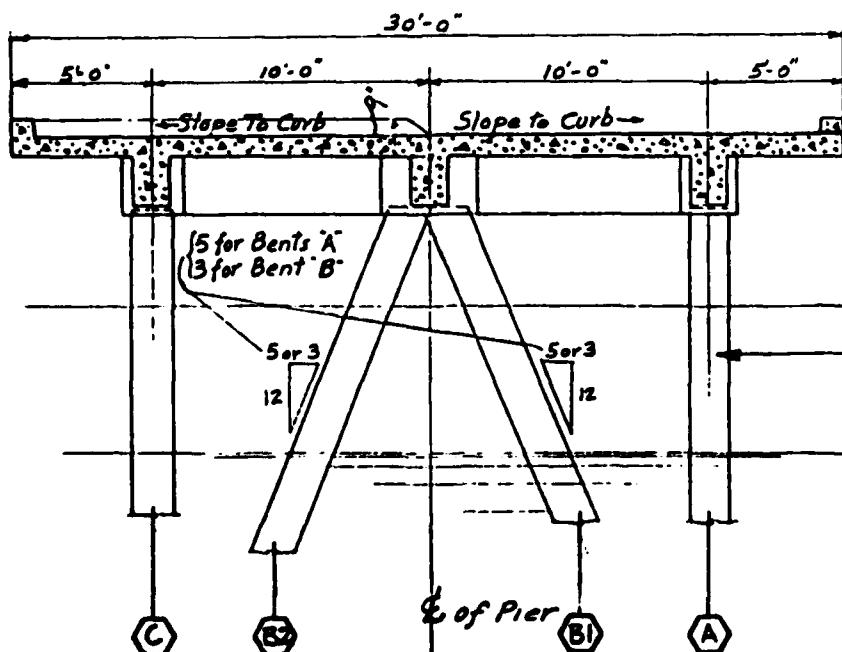


GRAPHIC SCALE		CHELSEA DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
		CH2M Engineering Corporation 200 52nd Street, San Francisco, CA	NAVAL STATION CHARLESTON, SC DWG. NO. 6
		PIER KILO	



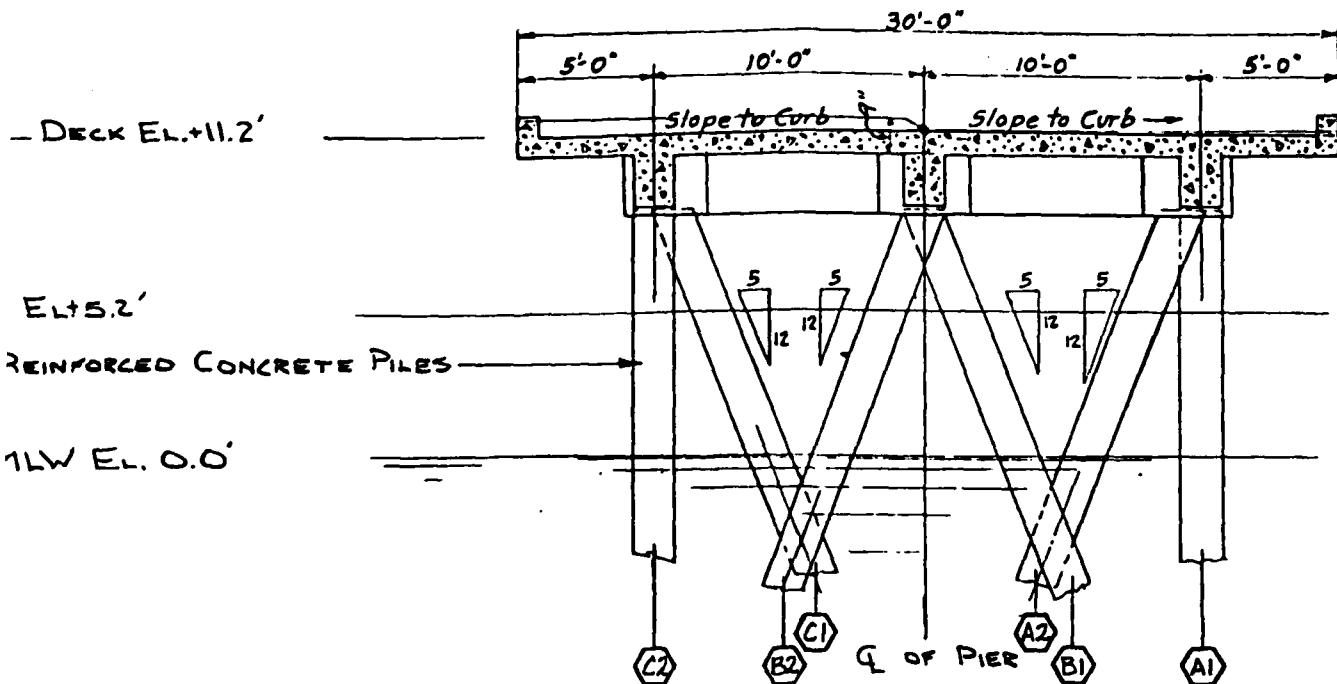
SECTION

(A)
67



SECTION

(C)
67



SECTION

(B)
67

LEGEND

- (2) - BATTER PILE DESIGNATION (FROM CHESDIV STANDARDS)
- (B) - PILE DESIGNATION (ELABORATION OF GOVERNMENT-FURNISHED DRAWINGS)

- DECK EL.+11.2'

MHW EL.+5.2'
REINFORCED CONCRETE PILES

W EL. 0.0'

NOTE: FROM Y&D Dwg. No. 426,223
"PIERS NOS. 1 to 6".

2	GRAPHIC SCALE	CH2M Engineering Corporation One Park Avenue, Inc.	CHEMPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
	0 5' 10' 15'		NAVAL STATION	CHARLOTTESVILLE, VA PIER NO. 7
			PIER KILO	

4.1.2 Observed Inspection Condition

No deterioration was noted in the piles installed in 1975.

Above mean low water (MLW), all the cylindrical encasements had hairline cracks and some cosmetic spalling. No evidence of rusting was seen and the concrete was generally hard.

From 5 feet below the pile cap to the base of the encasements, 28% of the jackets displayed spalled areas from 3" - 8" deep and softness up to 3" deep. These spalled areas ranged in size from 6" wide x 12" long to 18" wide x 8' long. Steel reinforcing was exposed in 71% of these piles.

Occasionally, the square pile just below the base of the encasement exhibited softness up to 1/2" deep. In one case (Bent 12, Pile A), just below the concrete jacket, the pile's cross section had been reduced by 260 sq. in. due to spalling of the concrete (this is an 80% loss in cross-sectional area).

The unencased piles exhibited cracking (maximum 1/4" wide) and cosmetic spalling within 3 - 5 feet of the pile cap with rusting evident (see Photo #2). The worst cracking occurred from Bents 8 to 15. Soft concrete (up to 1" deep) was associated with cracks greater than 1/32" in width around MLW (see Photo #3).

Soundings at the perimeter of the pier ranged from -3.0' to -46.0' below MLW on the north face and from -1.0' to -42.0' below MLW on the south face.

PHOTO #2: Typical Cracking (Maximum 1/4" Wide)
within 3 - 5 Feet of the Pile Cap,
with Rusting Evident (Pier KILO)

PHOTO #3: Example of Softness in Concrete (Maximum 1" Deep) Associated with Cracks
Greater Than 1/32" in Width, Around
Mean Low Water (Pier KILO)

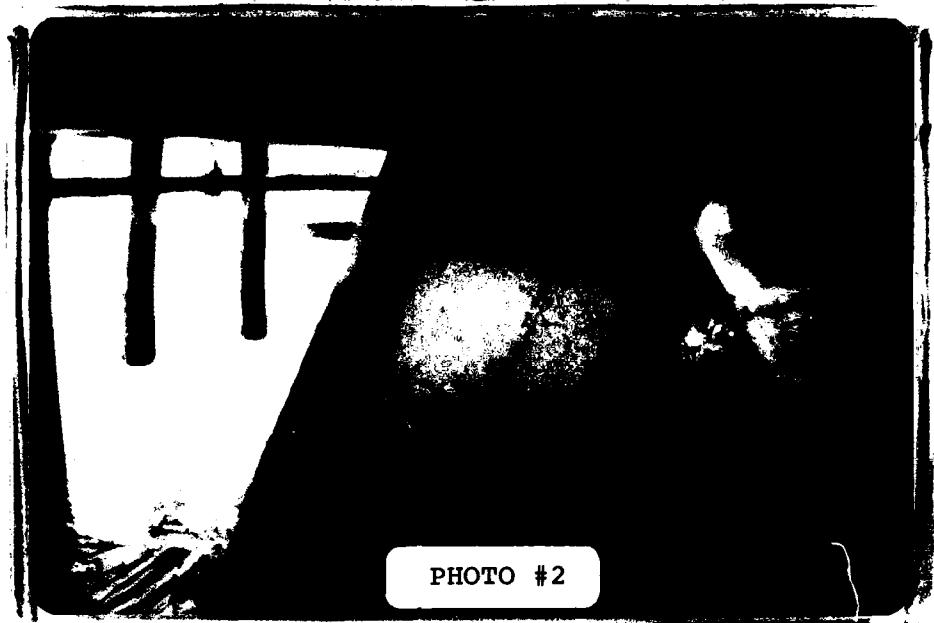


PHOTO #2

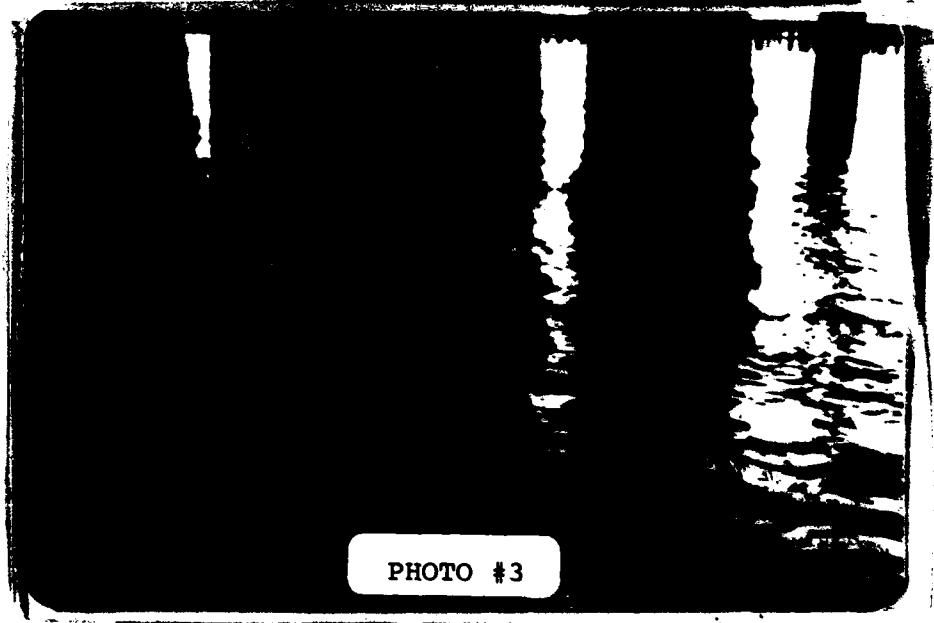


PHOTO #3

4.1.3 Structural Condition Assessment

Pier KILO appears to be in a satisfactory condition to handle the loads applied. Most of the deterioration observed was associated with the concrete encasements and resulted primarily from inadequate placement of the concrete below MLW. Continued deterioration of the jackets will substantially reduce the future life of the piles.

Cracks in concrete can also reduce the life of the piles by providing an access for water to enter the pile and the reinforcing bars. Freezing of water and corrosion of the reinforcing cause the concrete cover to spall. This allows further ingress of salt water into the pile. Repairs to stop this continuing deterioration are the only solution.

4.1.4 Recommendations

To protect the concrete piles from further deterioration, it is recommended that all cracks in the unencased concrete piles greater than 1/32" wide be repaired by pressure injecting an epoxy grout into the cracks. The estimated cost for this repair is \$40,000. In addition, all deteriorated concrete jackets which are not adequately protecting the concrete pile beneath them, should be replaced with new concrete jackets. The estimated cost for this repair could approach \$21,500.

Before repairs are performed, the cracks and spalled areas should be chipped and cleaned to sound concrete. Any exposed steel reinforcing should be cleaned and, if significantly deteriorated, replaced.

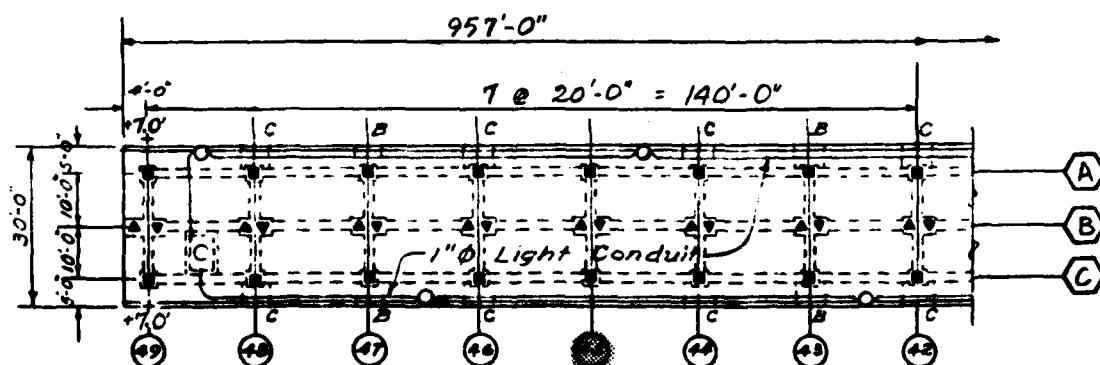
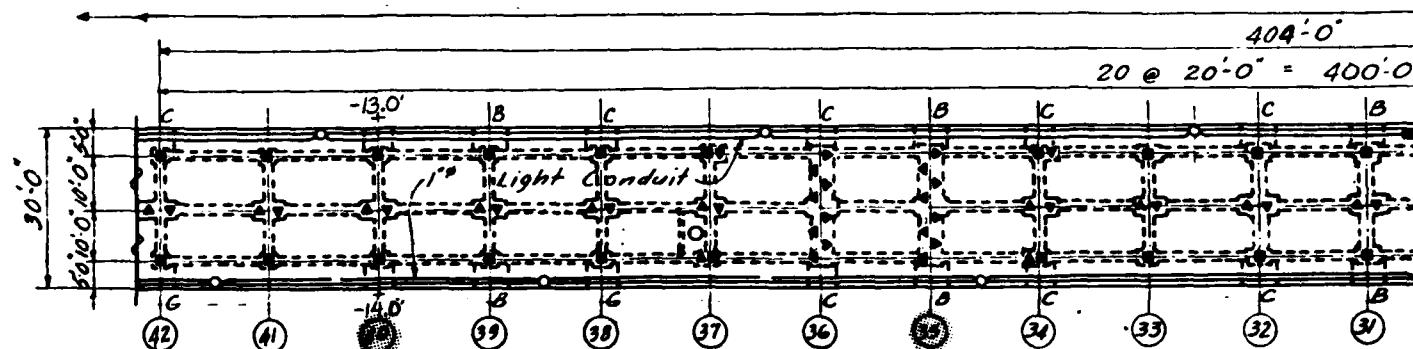
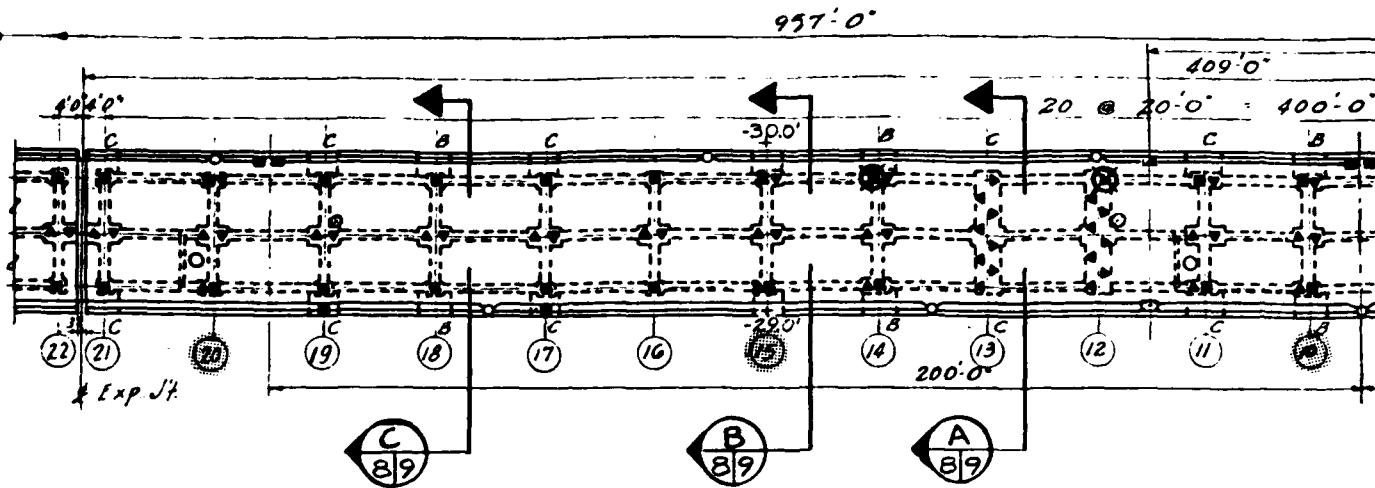
4.2 PIER LIMA

4.2.1 Description

Pier LIMA is located on the west bank of the Cooper River just south of Pier KILO and north of Pier MIKE. Pier LIMA provides berthing for up to four special purpose ships (AG) and is used for any overflow berthing.

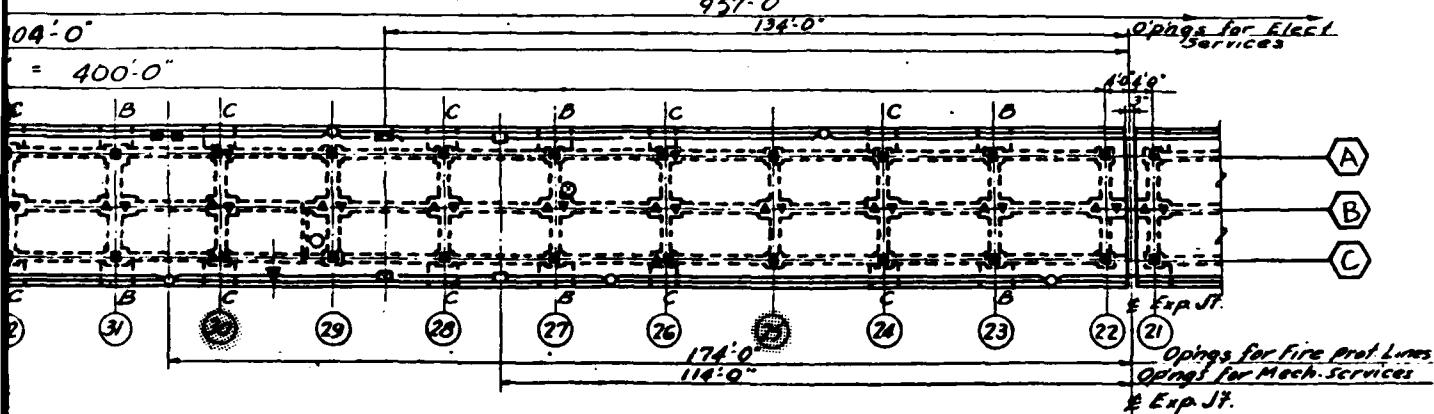
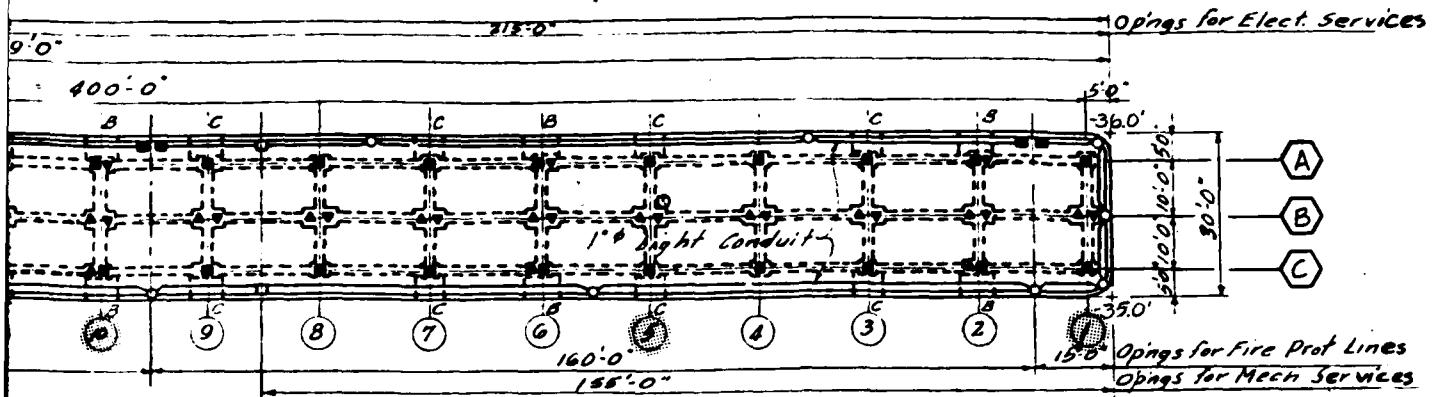
Pier LIMA was built in its present form around 1946. The 957' long x 30' wide pier is supported by 18" square precast, reinforced concrete piles (see Figure 8). There are 144 batter and 92 vertical bearing piles arranged in 49 bents which serve as foundation for the reinforced concrete deck (see Figure 9). In 1946, the pier design required a minimum bearing capacity of 50 tons for the piling and a deck live load of 300 PSF uniform load or H-15 loading plus 15% impact.

References: Naval Shipyard, Charleston, S.C.
"Facilities for Inactive Vessels -
Piers Nos. 1 to 6"
Y&D Dwg. #395,722 and #426,219



PLAN

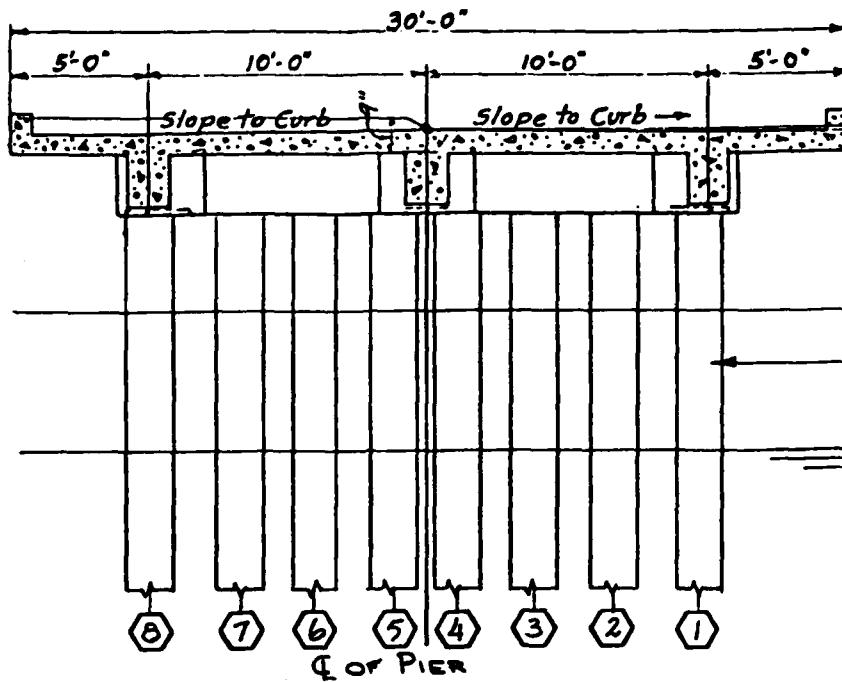
NOTE: PLAN TAKEN FROM Y&D DWG. NO. 395,722 AND 426,217.



LEGEND

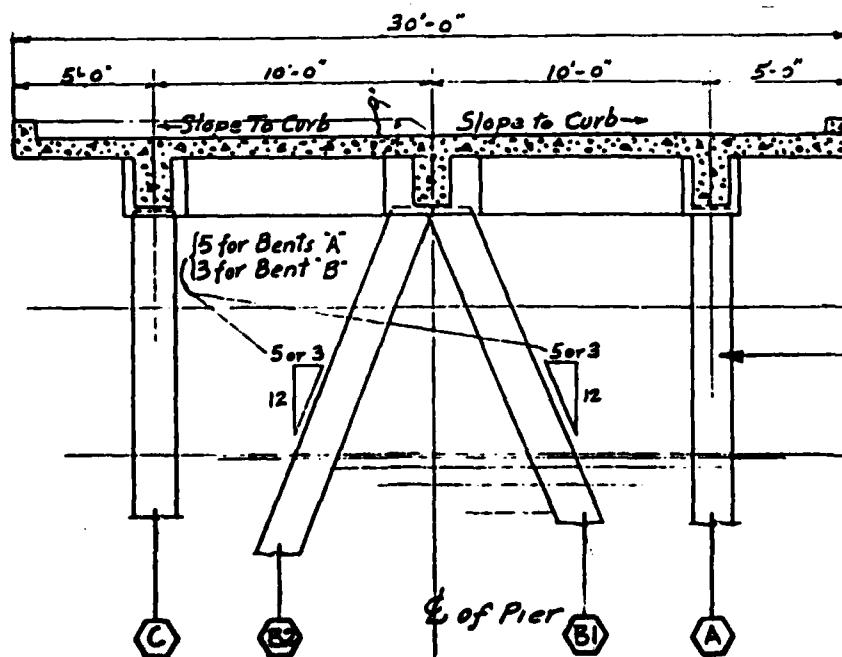
- (12) BENT No.
- (A) PILE DESIGNATION
- 21.0' SOUNDING (MLW)
- VERTICAL PILE
- ▼ BATTER PILE
- (S) CLOSELY INSPECTED BENT. REMAINING BENTS GIVEN CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2).
- (D) SIGNIFICANTLY DAMAGED PILE (SEE SECTION 4.2.2)

2	GRAPHIC SCALE	CH2M Engineering Corporation Box 333, Boston, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL STATION CHARLESTON, SC	PIER LIMA	PA NO. 8
	0' 10' 20' 30' 40' 50' 60' 70'				



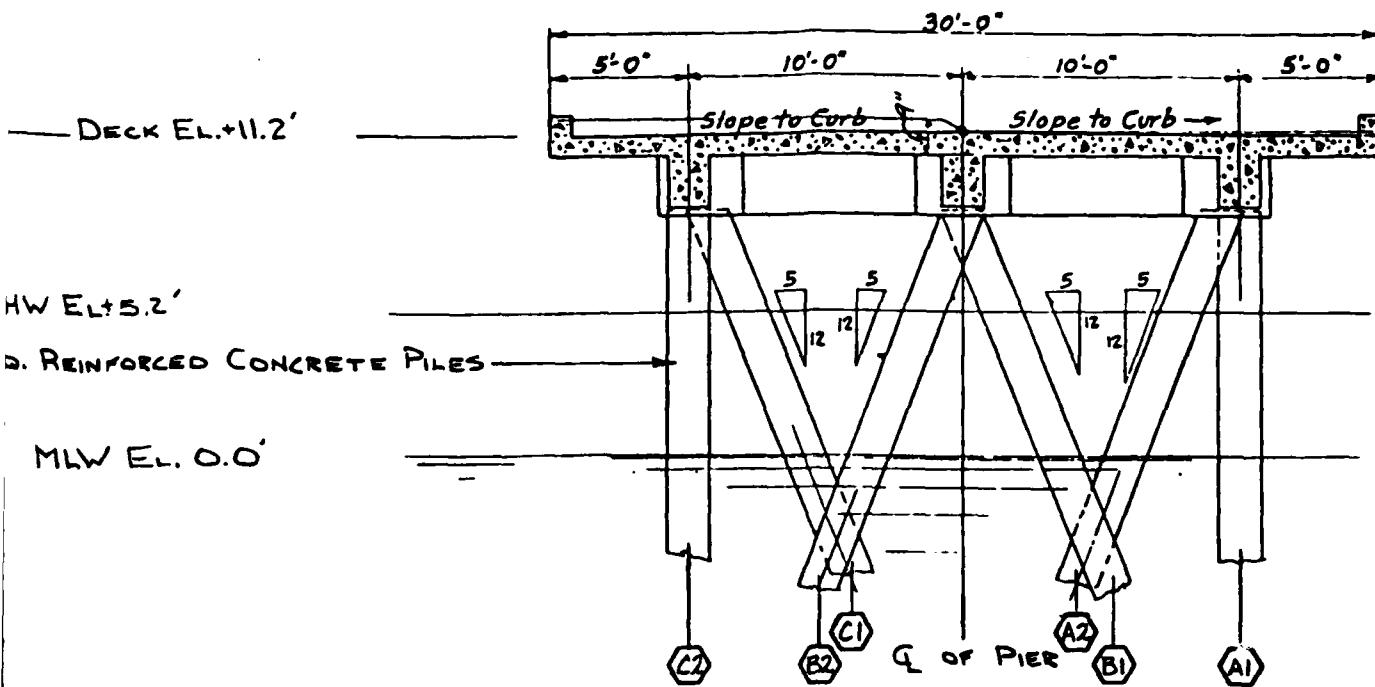
SECTION

(A)
B9



SECTION

(C)
B9



SECTION

B
819

LEGEND

(2) - BATTER PILE DESIGNATION (FROM CHESDIV STANDARDS)

(B) - PILE DESIGNATION (ELABORATION OF GOVERNMENT-FURNISHED DRAWINGS)

DECK EL.+11.2'

MHW EL.+5.2'

REINFORCED CONCRETE PILES

MLW EL. 0.0'

NOTE: FROM Y&D Dwg. No. 426,223
PIERS NOS. 1 TO 6.

2

GRAPHIC SCALE				CHILDS Engineering Corporation Box 233 MARINE, MD	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.
0	5'	10'	15'	NAVAL STATION CHARLESTON, SC	PAGE NO. 9

PIER LIMA

4.2.2 Observed Inspection Condition

Generally, cracking and cosmetic spalling of the piles were common within 5 feet of the pile cap. The cracks ranged from hairline to 1/4" in width with some evidence of rusting (see Photo #4). Approximately 70% of the piles had 1" of softness on the corners around mean low water (MLW) and around larger cracks (see Photo #5).

Fifteen piles exhibited spalling greater than 1" deep (maximum of 5" deep), in the area from the pile cap down to MLW. Of these, 12 piles had steel reinforcing exposed. Two piles were severely damaged (see Photo #6). One pile, Pile #1 in Bent 12, was fractured and spalled 4" - 5" deep just below the pile cap. At MLW, the pile was spalled in 3" for a 2-foot length on the north and east faces. Steel reinforcing was exposed in both areas. The second severely damaged pile, Pile A1 in Bent 14, was similarly fractured and spalled 4" deep around the pile head, with reinforcing exposed. The pile head appeared to be displaced 2" south.

Water depths along the perimeter of the pier ranged from -36.0' to +7.0' from MLW on the north face and -35.0' to +7.0' from MLW on the south face.

PHOTO #4: Example of Cracking and Spalling of Concrete Around Pile Head, with Rusting Evident and Reinforcing Exposed (Pier LIMA)

PHOTO #5: Typical Softness of Concrete (Up to 1" Deep) on Corners Around Mean Low Water (Pier LIMA)

PHOTO #6: Fractured and Displaced Pile Head of Pile A1 in Bent #14 of Pier LIMA

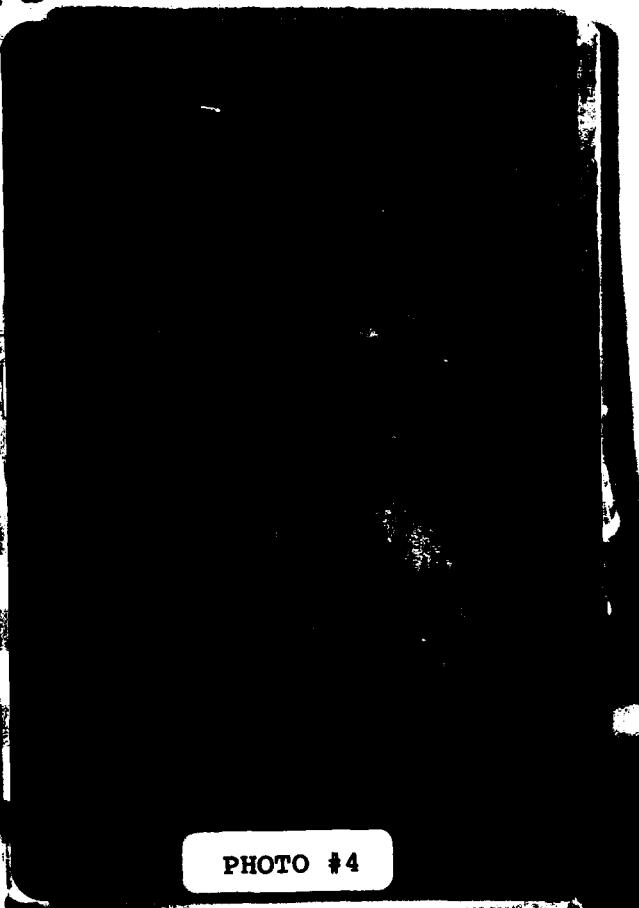


PHOTO #4



PHOTO #5



PHOTO #6

4.2.3 Structural Condition Assessment

Pier LIMA is in good condition. Although some deterioration has taken place, the overall capacity of the pier is not affected. Cracking and spalled areas are a concern. Water entering the pile through cracks and spalled areas can hasten deterioration of the piles.

The severe damage on two piles was probably caused by impact. Damage due to impact is a major problem. Aging of structural elements will deteriorate a pier over a long period of time, but impact damage can cause immediate destruction. Therefore, it is imperative that damage due to impact be immediately reported and repaired.

4.2.4 Recommendations

To prevent further deterioration of the concrete piles, it is recommended that all cracks greater than 1/32" wide and spalled areas greater than 1" deep be repaired as soon as possible by filling the voids in the piles with an epoxy grout. The estimated cost to repair these conditions is \$45,000.

Also, the two severely damaged piles should be repaired as soon as possible. One repair technique, if feasible, is to cast new reinforced pile sections in place of the damaged portions. Another repair technique is to drive new piles in place of the damaged piles. The estimated costs for these two repair techniques are, respectively, \$1,300 and \$10,000.

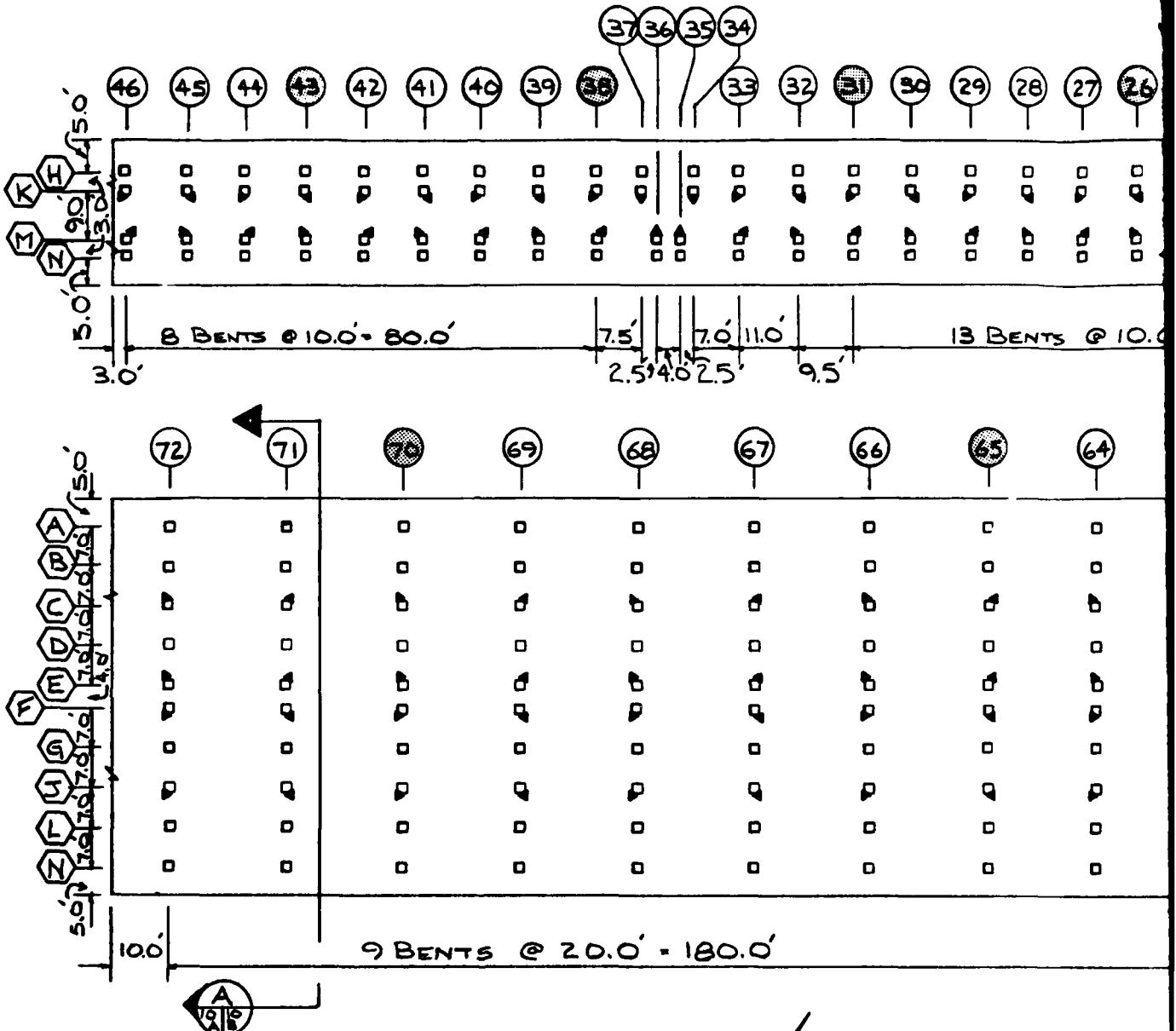
4.3 PIER MIKE

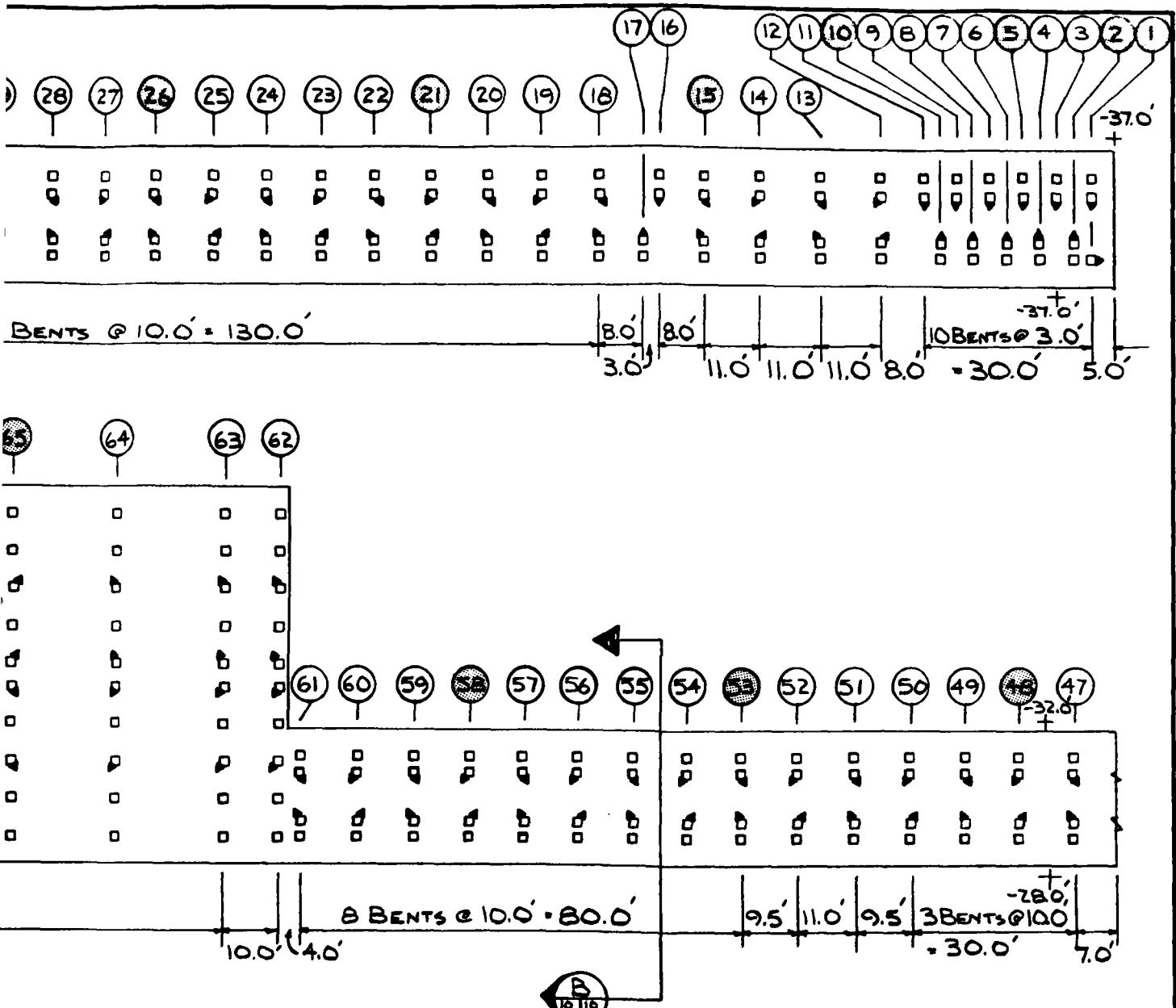
4.3.1 Description

Pier MIKE lies on the west bank of the Cooper River between Piers LIMA to the north and NOVEMBER to the south. Pier MIKE functions as the berth for a submarine tender (AS) and up to eleven nuclear submarines (SSN).

Pier MIKE was entirely rebuilt around 1975. It consists of a 600' long x 70' wide inboard section, 32 bents long, and a 500' long x 25' wide outboard section, 61 bents long, for mooring the AS. A total of 234 batter and 297 vertical bearing piles support the reinforced concrete decking. All piles are 18" square precast, reinforced concrete (see Figures 10A and 10B).

References: Southern Division, Naval Facilities Engineering Command
"Additional Berthing - Structural"
NAVFAC Dwg. #5036633 and #5036637

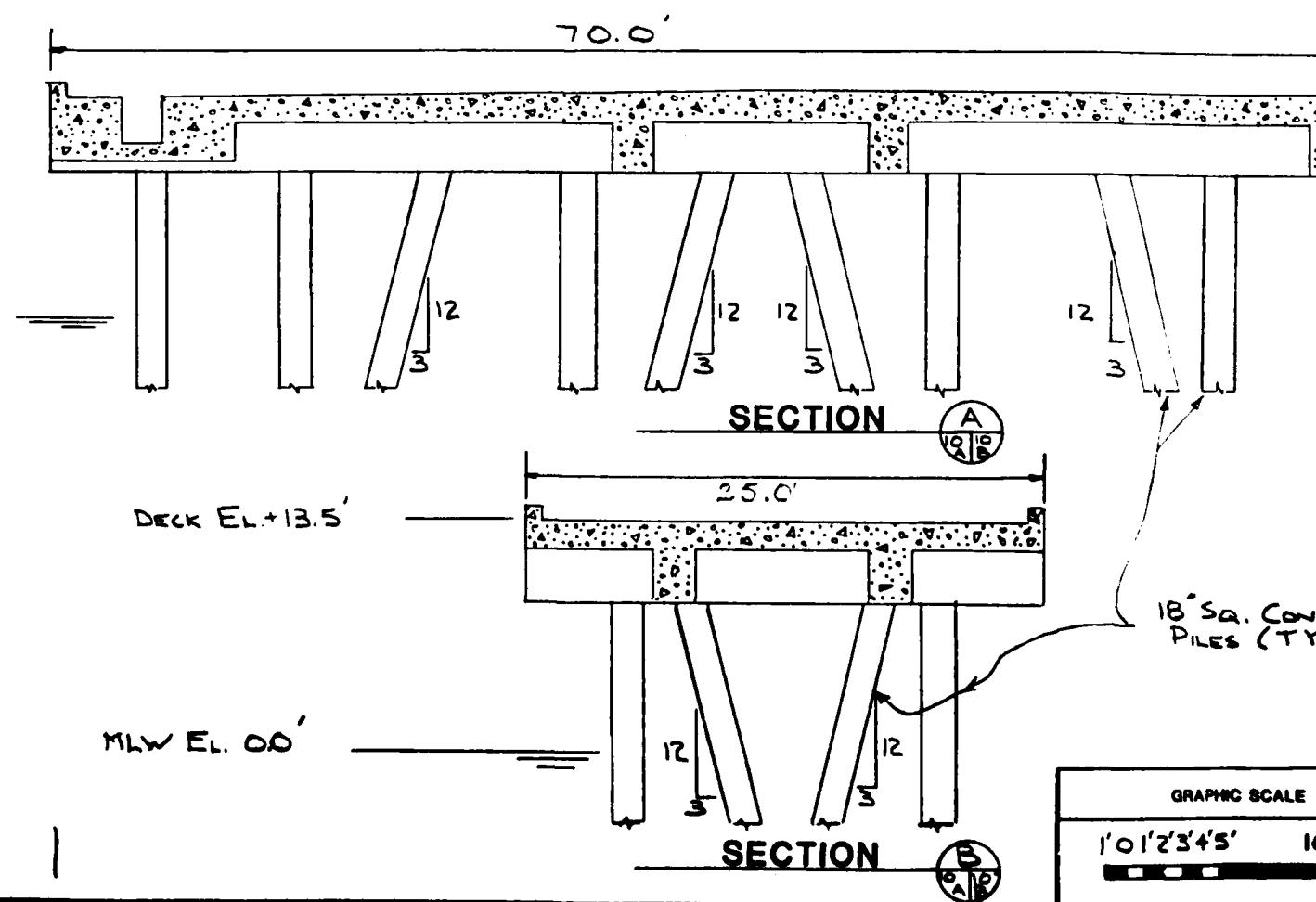
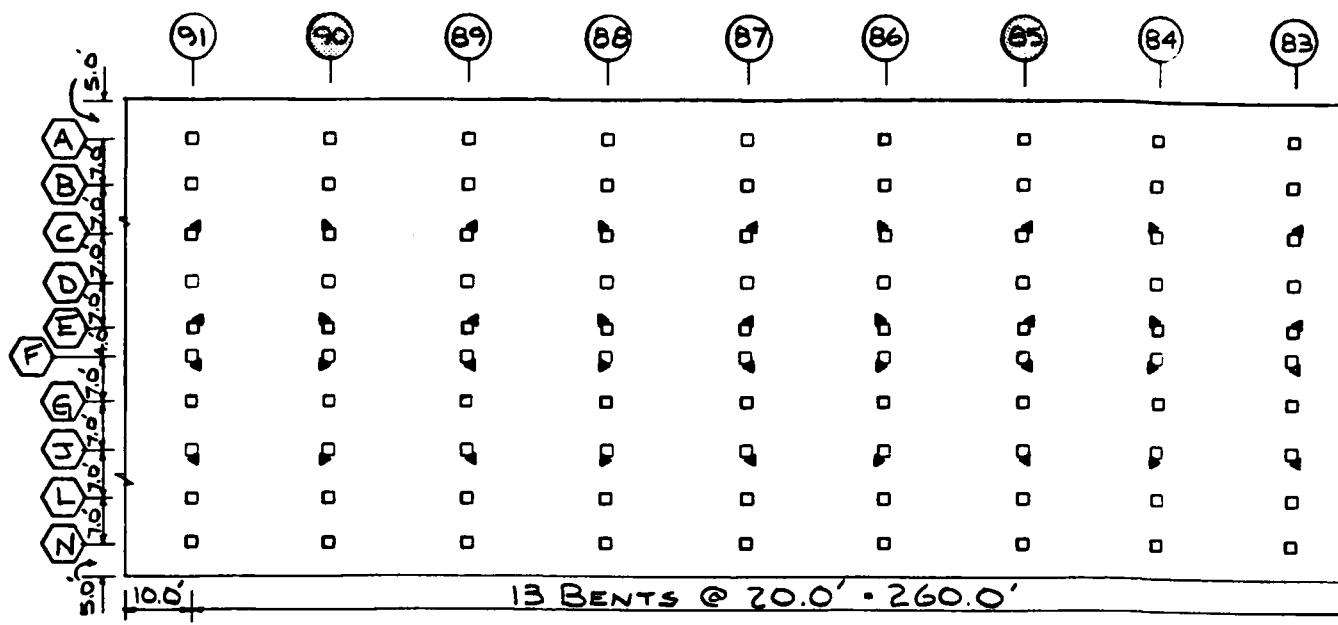


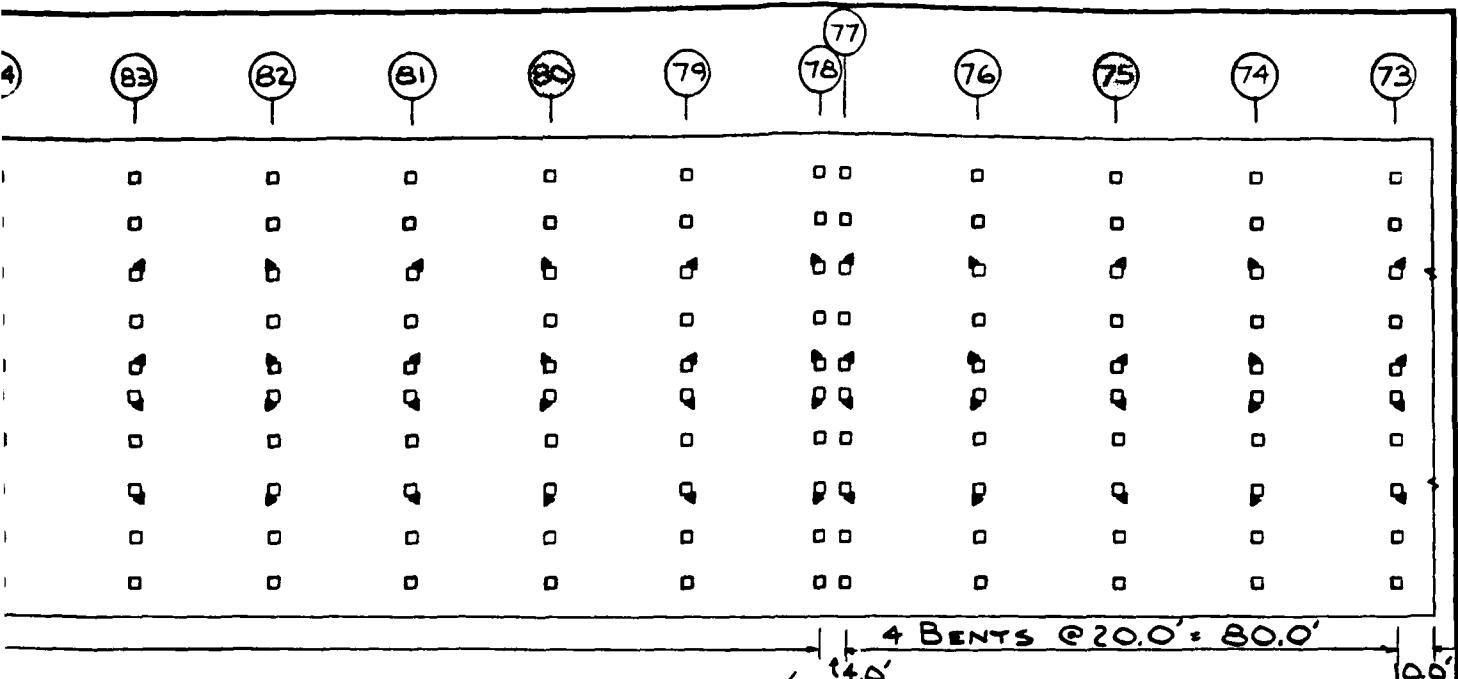


FROM: NAVFAC DRWG. NO. 5036633 "ADDITIONAL
BERTHING - STRUCTURAL - PIER M."

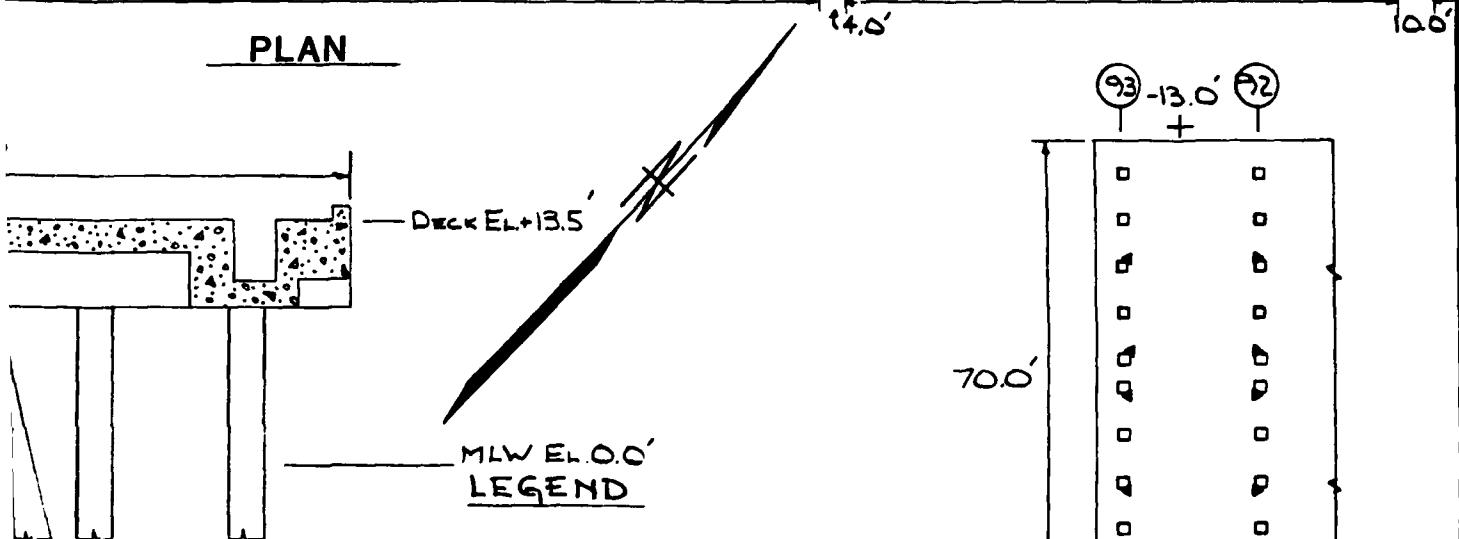
2

GRAPHIC SCALE	CH2M Engineering Corporation One 330 Avenue, MA	NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL STATION CHARLESTON, SC	PIC. NO.
5' 0" 10' 20' 30' 40'		PIER MIKE	10A





PLAN



MLW E.L.O.O'
LEGEND

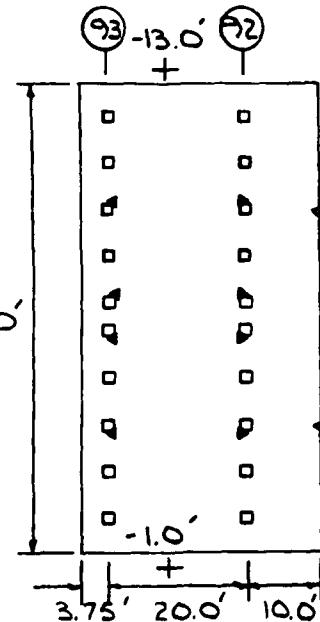
(2) - BENT 'No.'

(B) - PILE DESIGNATION

+ -21.0 SOUNDED (MLW)

(C) - CLOSELY INSPECTED BENT. REMAINING BENTS GIVEN
CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2).

FROM: NAVFAC DRWG. NOS. 5036633
5036637



PLAN

18" Sq. CONCRETE
PILE (TYP.)

GRAPHIC SCALE	GRAPHIC SCALE	Childs Engineering Corporation Box 325 Woburn, MA	CHEMPSAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.
2'3" 5' 10' 15'	5' 0" 10' 20' 30' 40'		NAVAL STATION CHARLESTON, SC P.D. NO. PIER MIKE 10B

4.3.2 Observed Inspection Condition

Except for occasional cosmetic spalling on the corners (see Photo #7) and air pockets in the concrete, no unusual conditions or damage was observed.

Soundings along the perimeter of the pier ranged from -37.0' below mean low water (MLW) on the outshore end to -1.0' below MLW on the inshore south face and -13.0' below MLW on the inshore north face.

4.3.3 Structural Condition Assessment

Pier MIKE is in an excellent condition. No structural anomalies or deterioration was observed to reduce the capacity of any pile. Any spalling noted is not of significant proportion.

4.3.4. Recommendations

No repairs are needed at this time. Pier MIKE should be reinspected in 10 years to document any deterioration. This report should be used as a baseline for this future inspection and in determining the rate of deterioration.

PHOTO #7: Example of Popout in Concrete at
Pile Head (Pier MIKE)

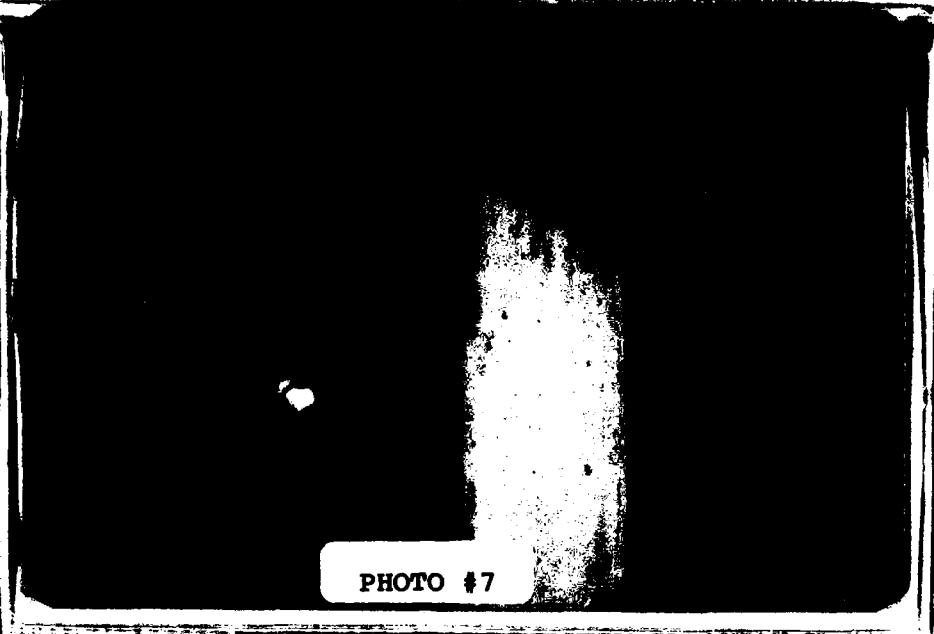


PHOTO #7



4.4 PIER NOVEMBER

4.4.1 Description

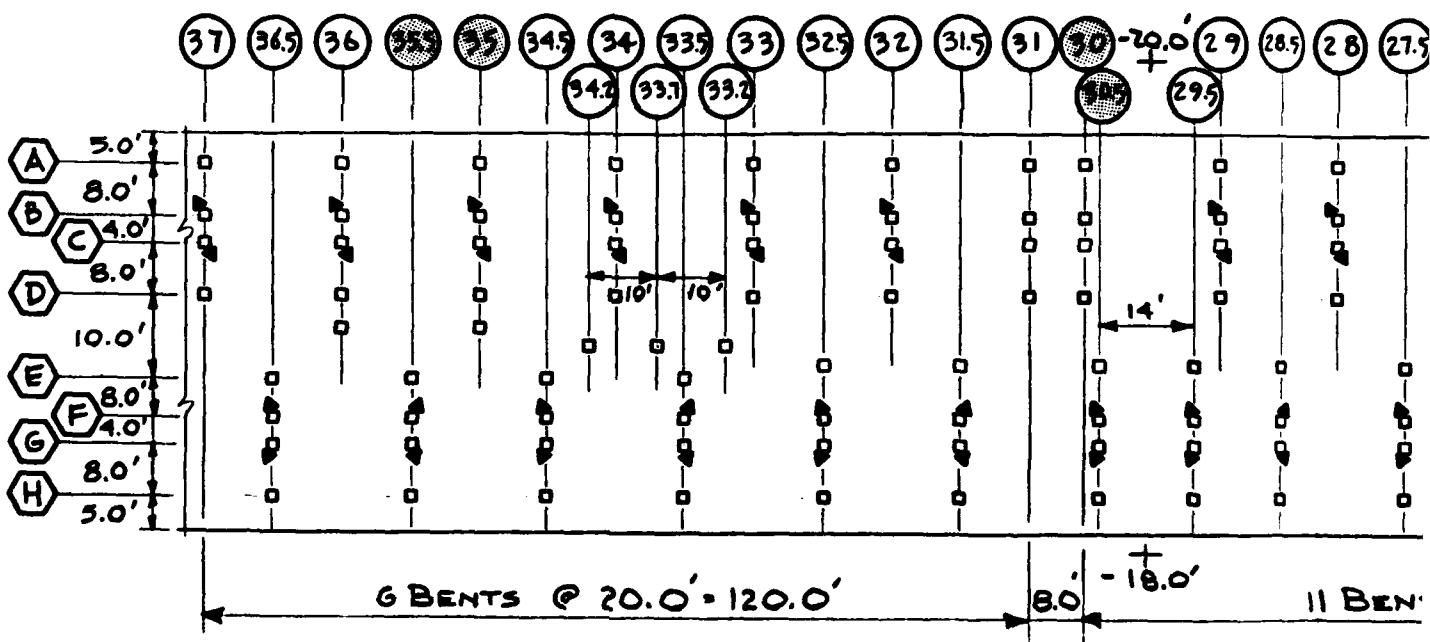
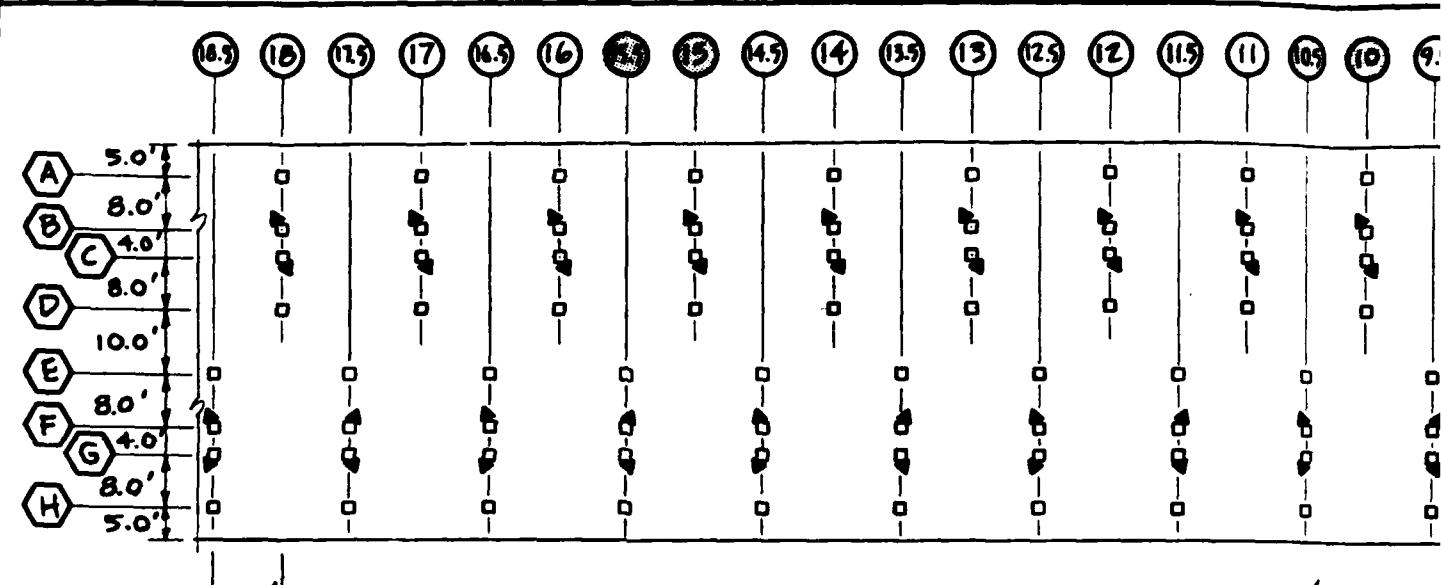
Pier NOVEMBER is located on the west bank of the Cooper River, adjacent to Pier MIKE to the north and Pier PAPA to the south. It provides berthing for frigates (FF), destroyers (DD), guided missile equipped destroyers (DDG) and guided missile equipped cruisers (CG), and can accommodate up to six ships at one time.

Pier NOVEMBER was built around 1946 and widened in 1964. In 1976, the 1946 portion of the pier was replaced with new piles and decking, so at present the northern half of the pier is about 10 years older than the southern half. The piles are all 18" square precast, prestressed concrete and designed for a 75-ton capacity (when the 1976 reconstruction occurred, the design load of the existing 1964 piles was downgraded to 50 tons). The 1157' long x 60' wide pier has a reinforced concrete deck, supported by 59 bents comprised of 110 batter and 130 vertical bearing piles on the northern half (1964) and 140 batter and 127 vertical bearing piles on the southern half (1976; see Figures 11A and 11B). The design live loading is 500 PSF uniform loading or H-20 truck loading with 15% impact for the northern half of the pier deck and 500 PSF uniform loading or HS20-44 truck loading for the southern half of the pier deck.

References: Naval Shipyard, Charleston, S.C.
"Facilities for Inactive Vessels - Piers
Nos. 1 to 6"
P.W. Dwg. #H325-3

Southeast Division, Bureau of Yards and Docks
"Extension of Fleet Piers and Utilities"
Y&D Dwg. #967299 and #967308

Southern Division, Naval Facilities Engineering Command
"Ship Berthing Improvements - 4th Increment - Structural"
NAVFAC Dwg. #5021003 and #5021005



LEGEND



BENT NO.



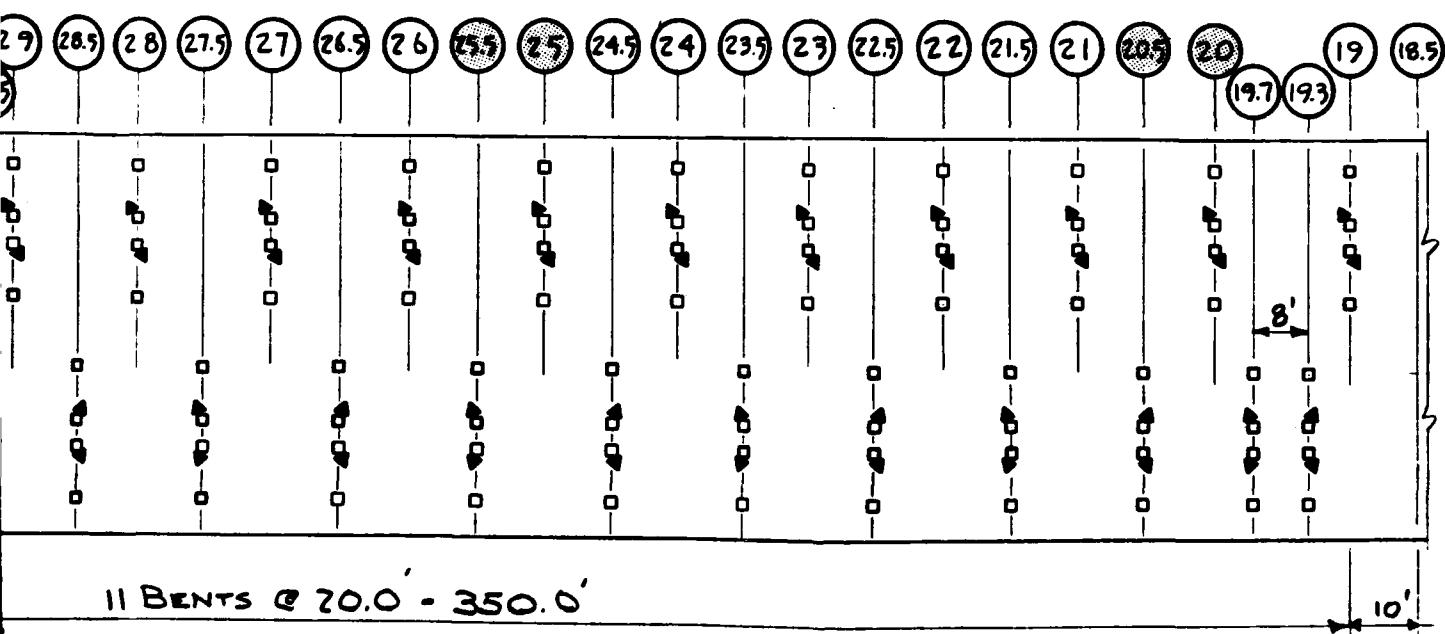
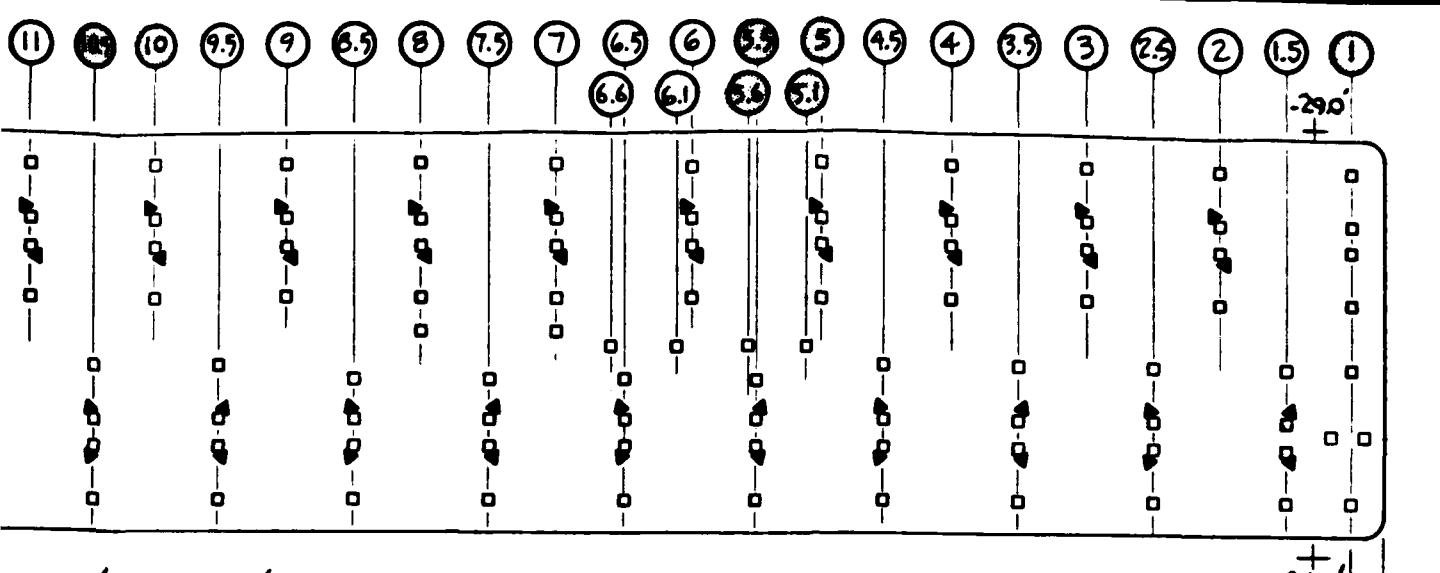
PILE DESIGNATION



-20.0' SOUNDING (MLW)

CLOSELY INSPECTED BENT. REMAINING BENTS GIVEN
CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2).

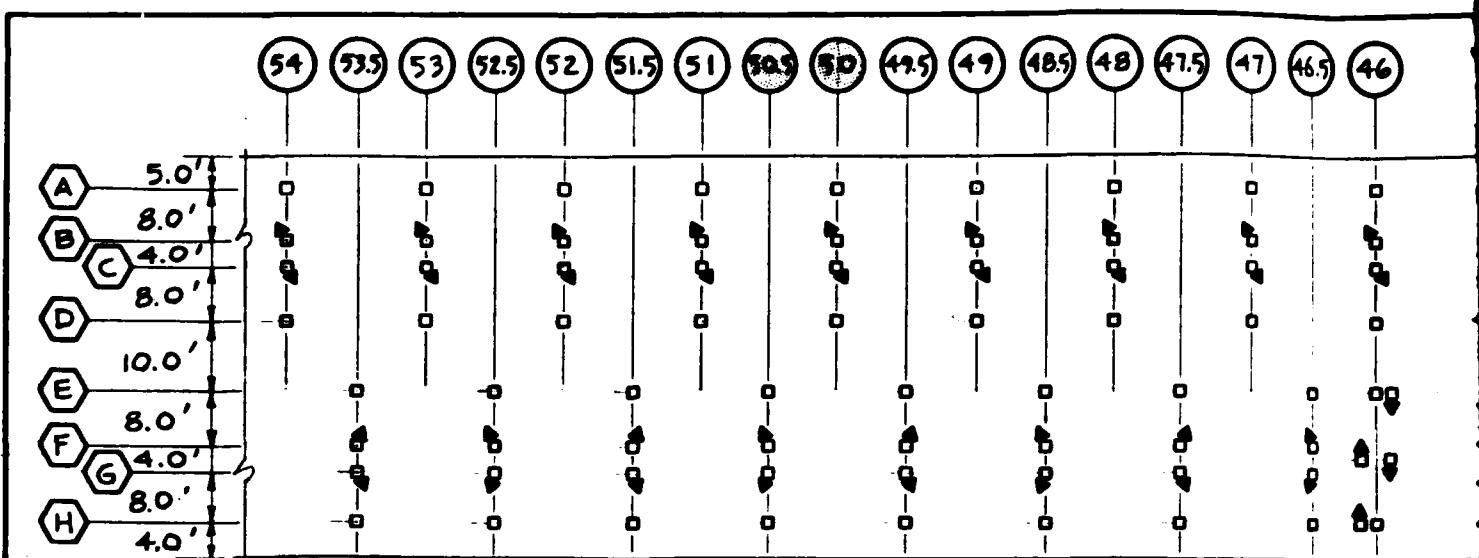
NOTE: FROM NAVFAC Dwg. No 5021003
AND Y'D Dwg. No. 967299



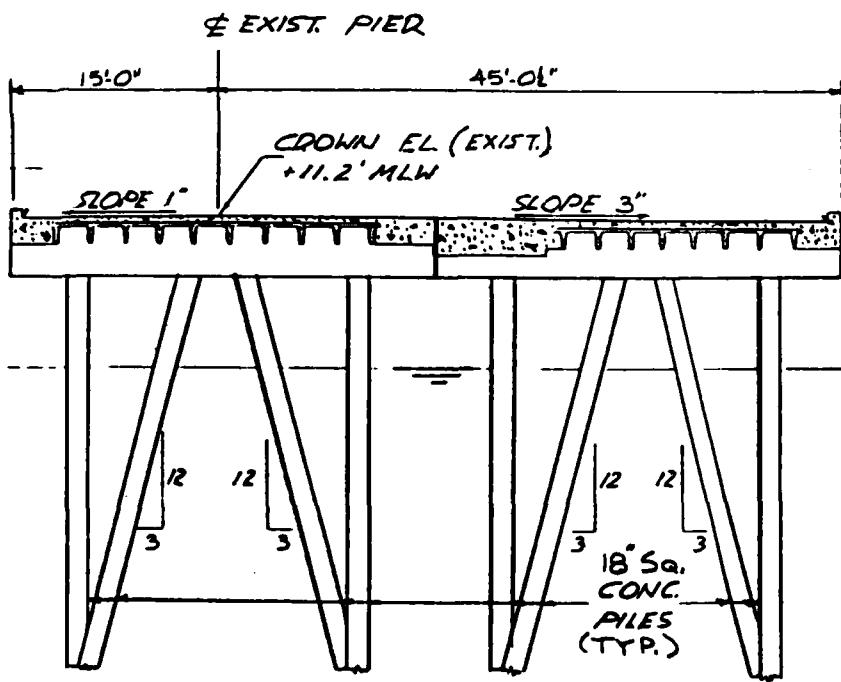
2

GRAPHIC SCALE					CH2M Engineering Corporation One 355 Madison, Inc.	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.		
10' 0' 10' 20' 30' 40' 50'						NAVAL STATION CHARLESTON, SC	PUB. NO. 11A	

PIER NOVEMBER



17 BENTS @ 20.



LEGEND



BENT NO.



PILE DESIGNATION



-20.0' SOUNDING (MLW)



CLOSELY INSPECTED BENT. REMAINING BENTS GIVEN
CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2).

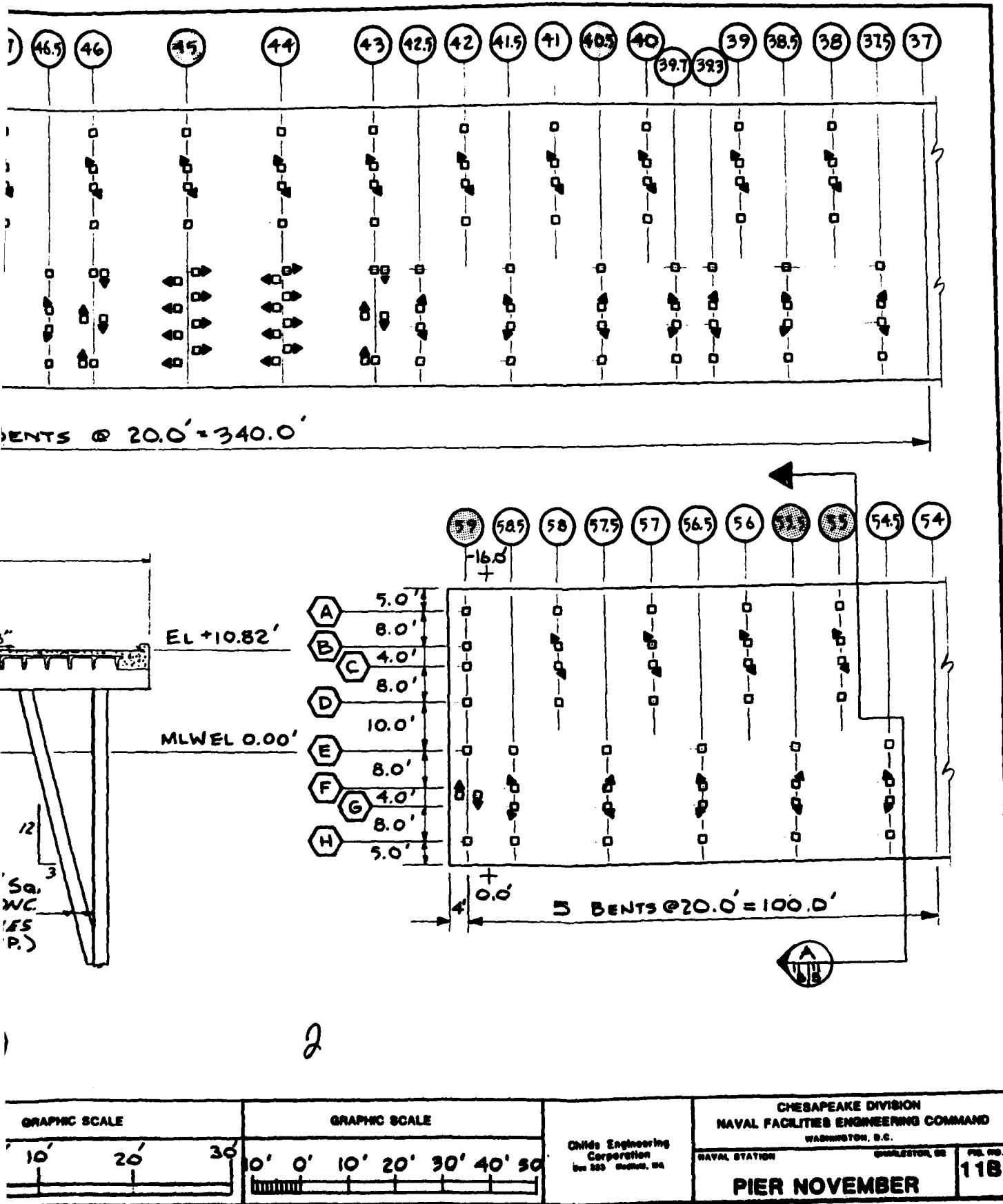
NOTE: FROM NAVFAC Dwg. No. 5021003 AND
Y&D Dwg. No. 967299

SECTION



GRAPHIC SCALE

0' 5' 10' 20'



4.4.2 Observed Inspection Condition

No damage or deterioration was noted.

Water depths ranged from -16.0' to -29.0' below mean low water (MLW) on the north face of the pier and 0.0' to -26.0' below MLW on the south face.

4.4.3 Structural Condition Assessment

Pier NOVEMBER is in an excellent condition.

4.4.4 Recommendations

No repairs are recommended at this time. This pier should be reinspected in 10 years, using this report as a baseline. At that time, any deterioration should be recorded and its rate should be determined.

4.5 PIER PAPA

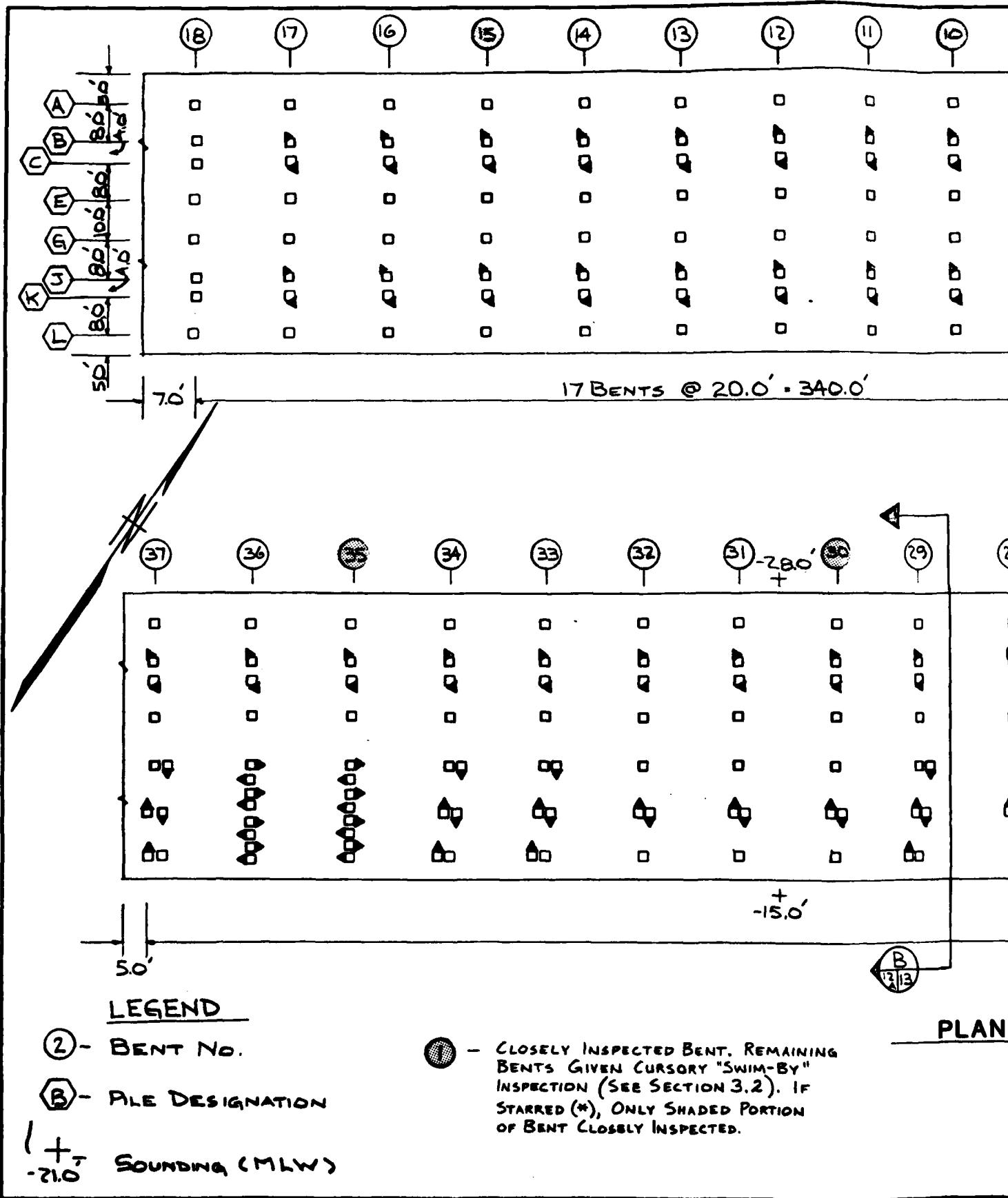
4.5.1 Description

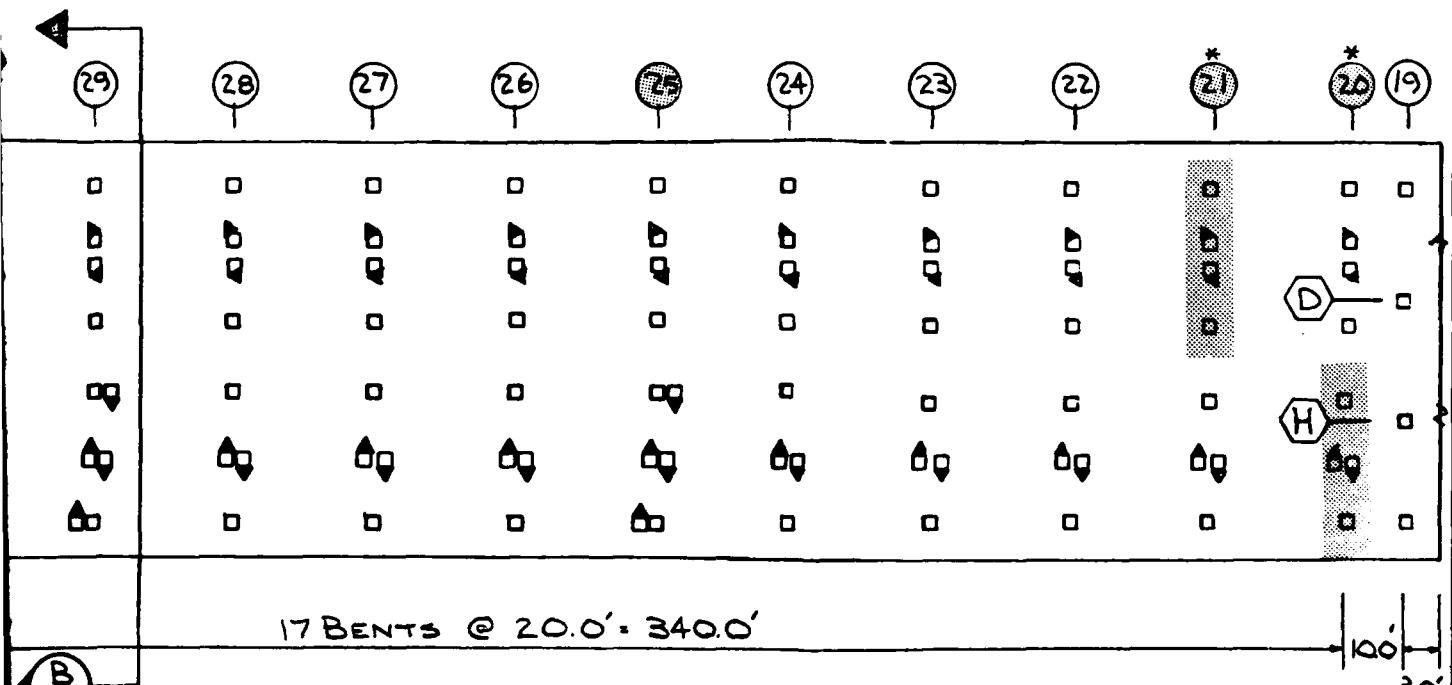
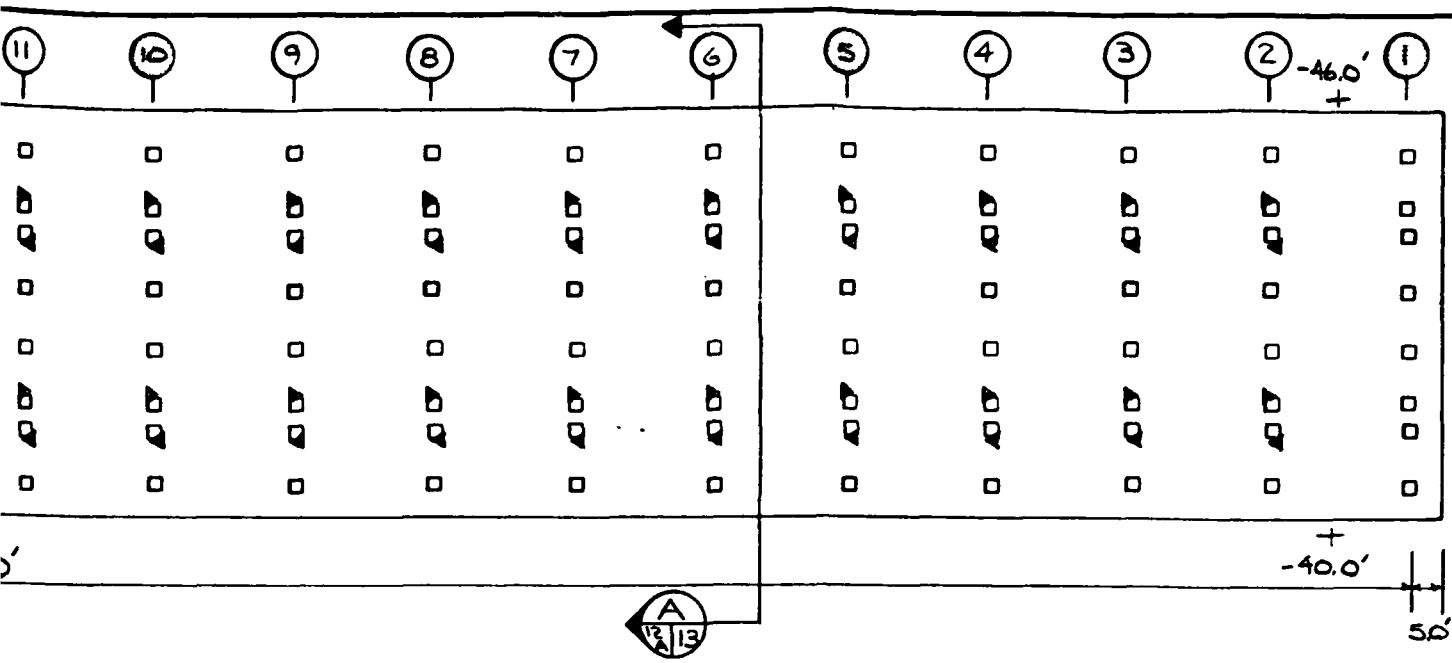
Located on the west bank of the Cooper River, Pier PAPA lies between Pier NOVEMBER to the north and Pier QUEBEC to the south. Pier PAPA can accommodate one destroyer tender (AD) and up to five destroyers (DD) or guided missile equipped destroyers (DDG).

Pier PAPA was built around 1946 and was 51 bents long. In 1963, it was extended by 19 bents and widened to the north to its present configuration (see Figures 12A, 12B and 13). The piles are 18" square precast, reinforced concrete (the newer piles are prestressed). The piles in the original 1946 structure were designed for a minimum bearing capacity of 50 tons and the reinforced concrete deck was designed for a live load of 300 PSF uniform load or H-15 loading plus 15% impact. The design criteria for the 1963 portion of the facility required bearing piles with a capacity of 75 tons and a reinforced concrete deck with a live load of 500 PSF uniform loading or H-20 truck loading with 15% impact. The 1357' long x 60' wide pier has 148 batter and 108 vertical bearing piles in the older portion and 160 batter and 180 vertical bearing piles in the newer portion.

References: Naval Shipyard, Charleston, S.C.
"Facilities for Inactive Vessels - Piers
Nos. 1 to 6"
P.W. Dwg. #H325-3 and #H325-4

Southeast Division, Bureau of Yards and Docks
"Extension of Fleet Piers & Utilities"
Y&D Dwg. #967302 and #967308



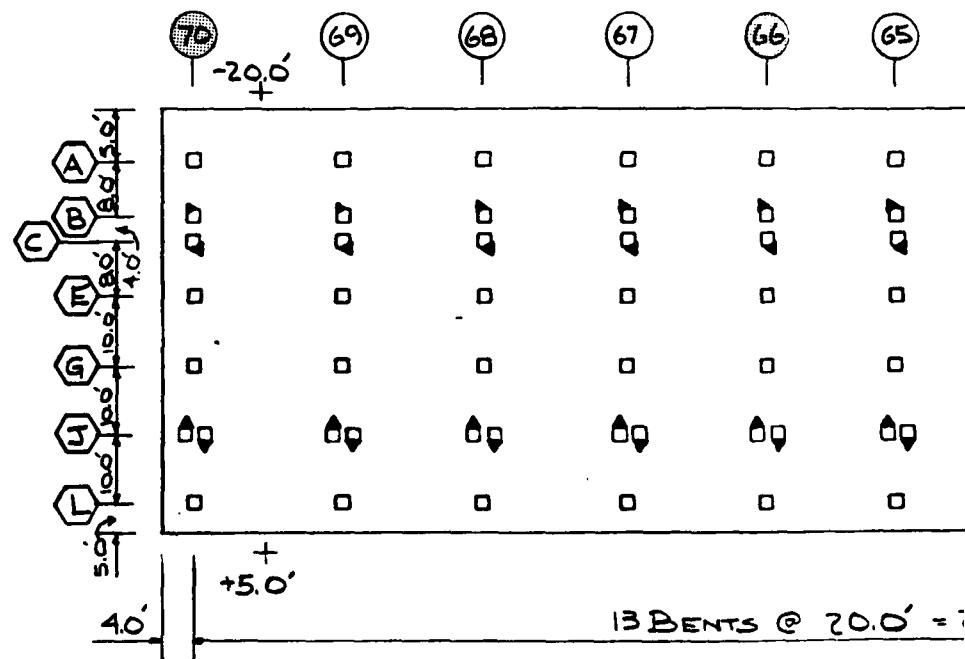
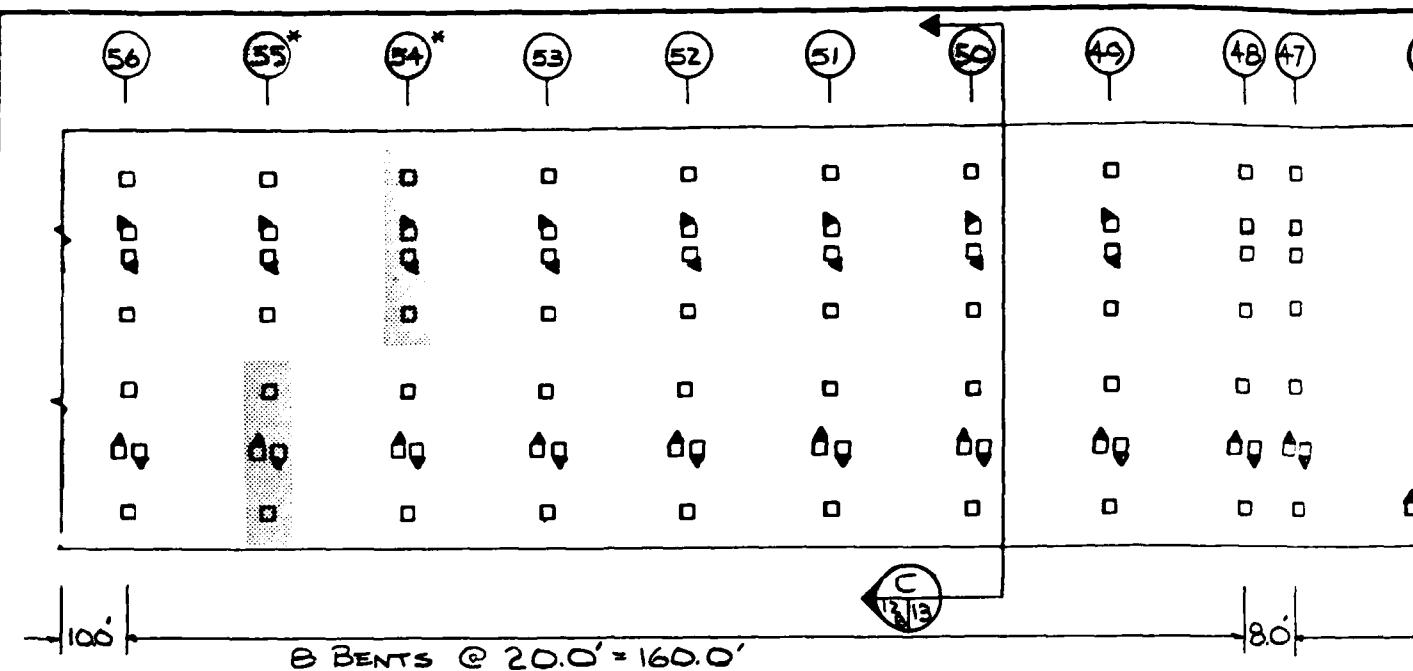


PLAN

FROM: Y&D Draw. No. 967302 "EXTENSION OF FLEET PIERS & UTILITIES, PIER PAPA".

GRAPHIC SCALE	CNHD's Engineering Corporation Box 330 Somerville, MA	CHEMPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL STATION CHARLESTON, SC
5' 0" 10' 20' 30' 40'		PIER PAPA

12A



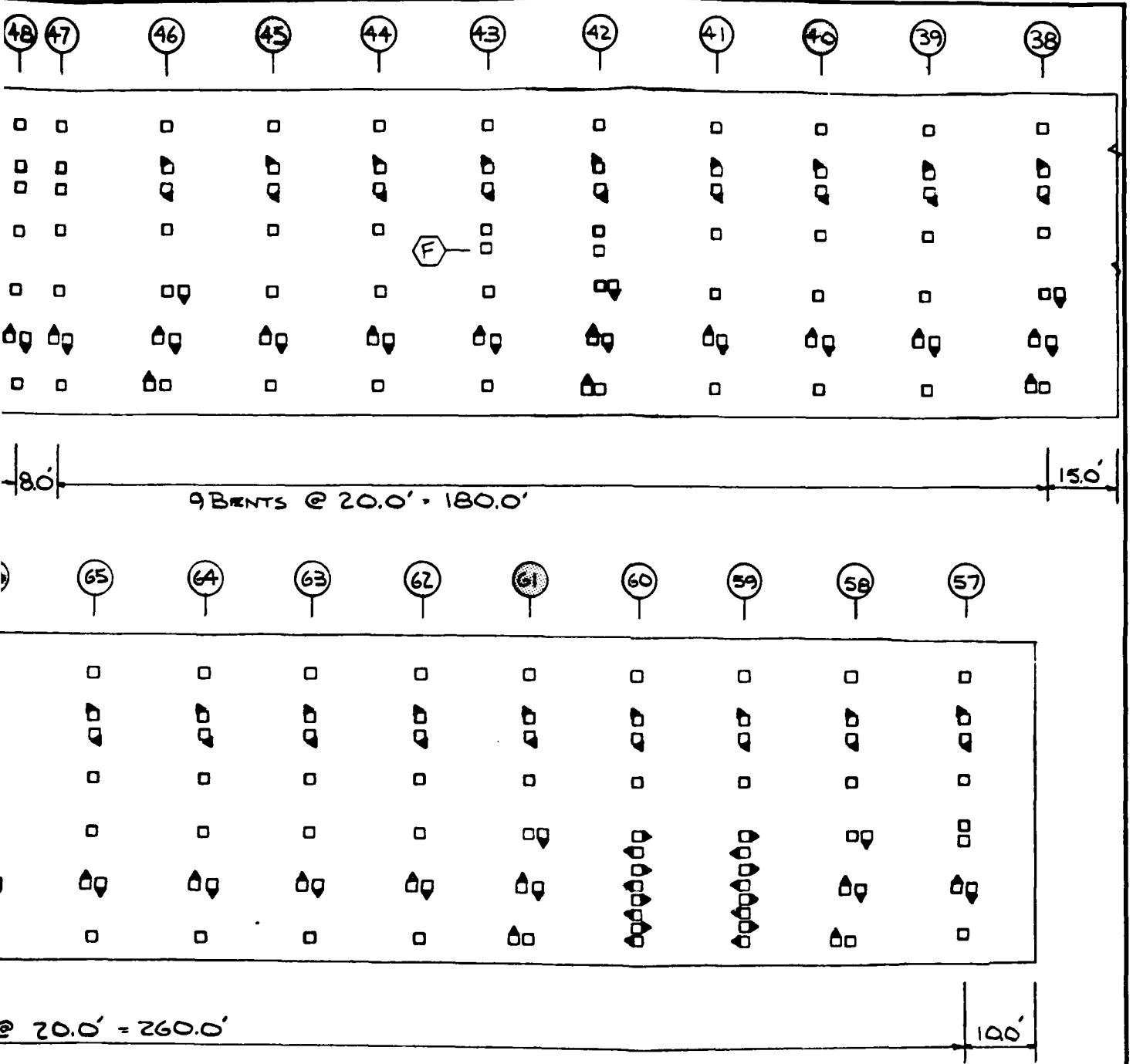
LEGEND

(2) - BENT No.

B- FILE DESIGNATION

1. Sounding (MLW)

- CLOSELY INSPECTED BENTS. REMAINING BENTS GIVEN CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2). IF STARRED (*), ONLY SHADED PORTION OF BENT CLOSELY INSPECTED.

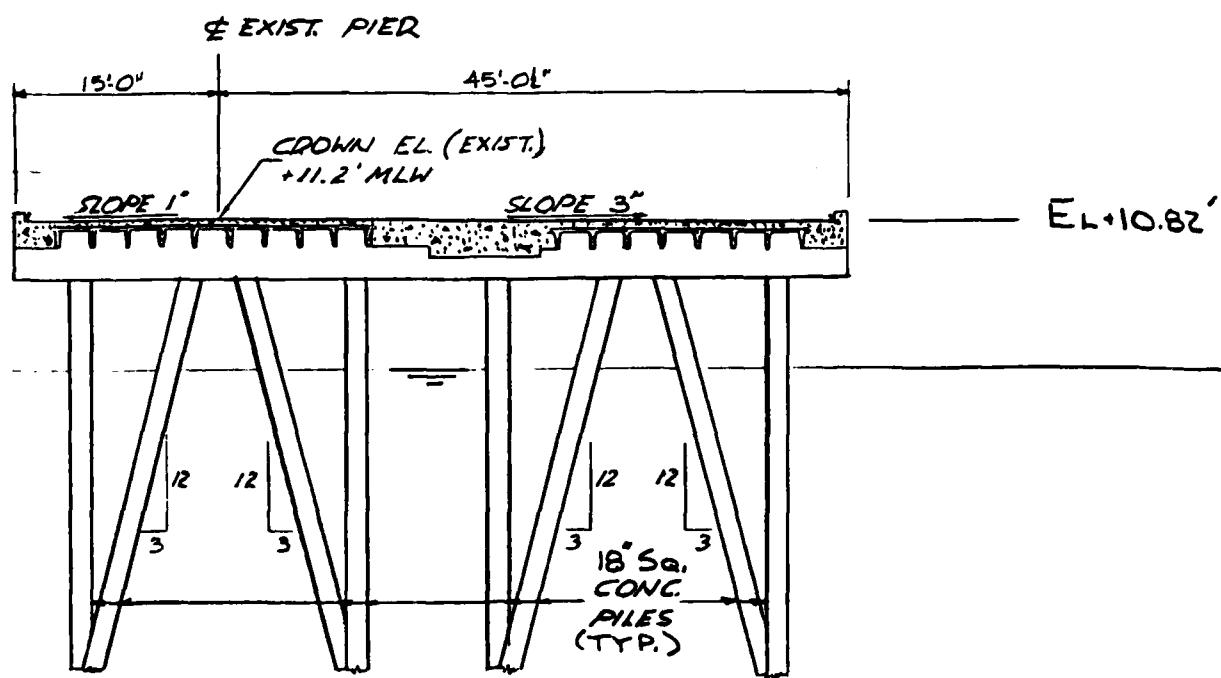


PLAN

2 FROM: Y&D Dwg. No. 967302 "EXTENSION OF
FLEET PIERS & UTILITIES - PIER PAPA".

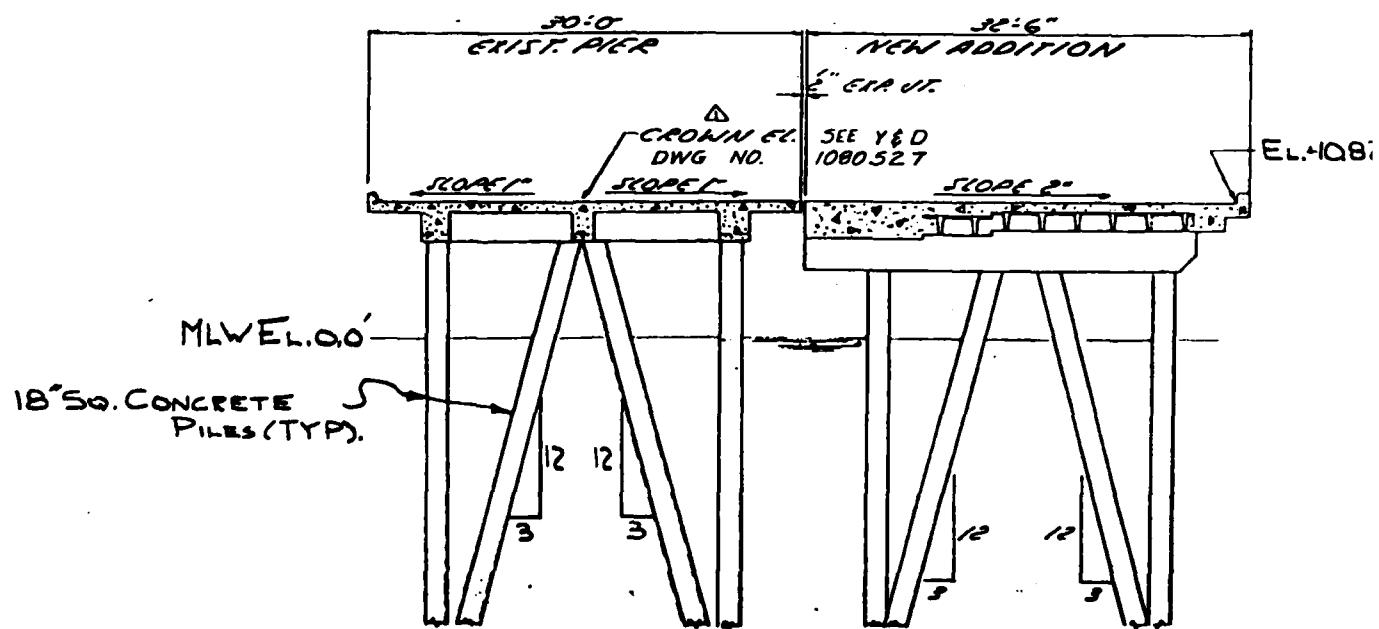
ENTS GIVEN
SECTION 3.2).
BENT

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION Box 323 BOSTON, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL STATION CHARLESTON, SC PIER PAPA
5' 0" 10' 20' 30' 40'		PIR. NO. 12B



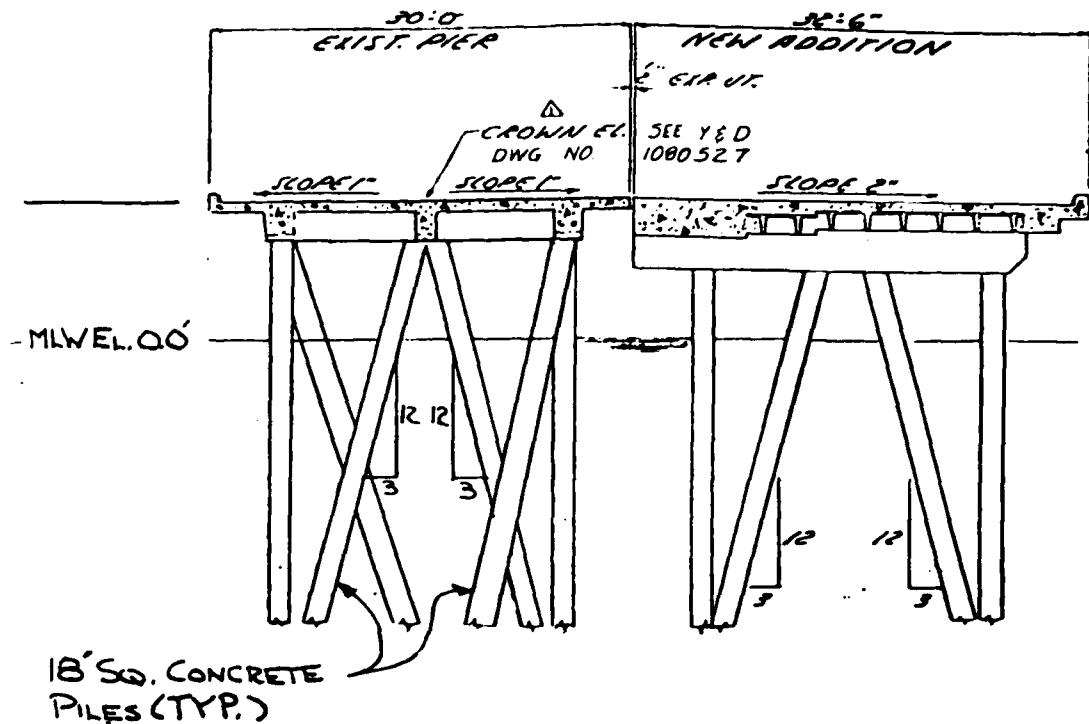
SECTION

A
13



SECTION

C
13

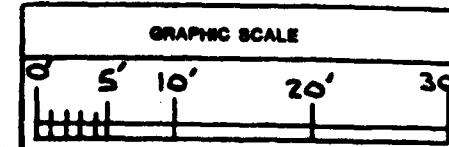


SECTION

B
12/13

EL. +10.82'

2



CHADS Engineering
Corporation
Box 333 - Boston, MA

CHEAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

NAVAL STATION CHARLESTON, SC

PIER PAPA

PAGE NO.
13

4.5.2 Observed Inspection Condition

From Bents 20 to 70 of the pier, the piles exhibited cosmetic spalling on corners and some hairline cracking in the area from the pile cap to mean low water (MLW). Approximately 50% of the older piles had cracks up to 1/8" in width and softness up to 1" deep, in the area from MLW to mean high water. All the older piles had been patched around the pile head. There was some cracking and rusting around these patches and 10% had been spalled out (see Photo #8). The worst conditions were observed on Pile L in Bent 67. On one corner, a 1/4" crack ran from the pile cap to the mudline, and on another corner, an area within 6" of the pile cap was spalled 3" in. No rust or reinforcing was exposed, however.

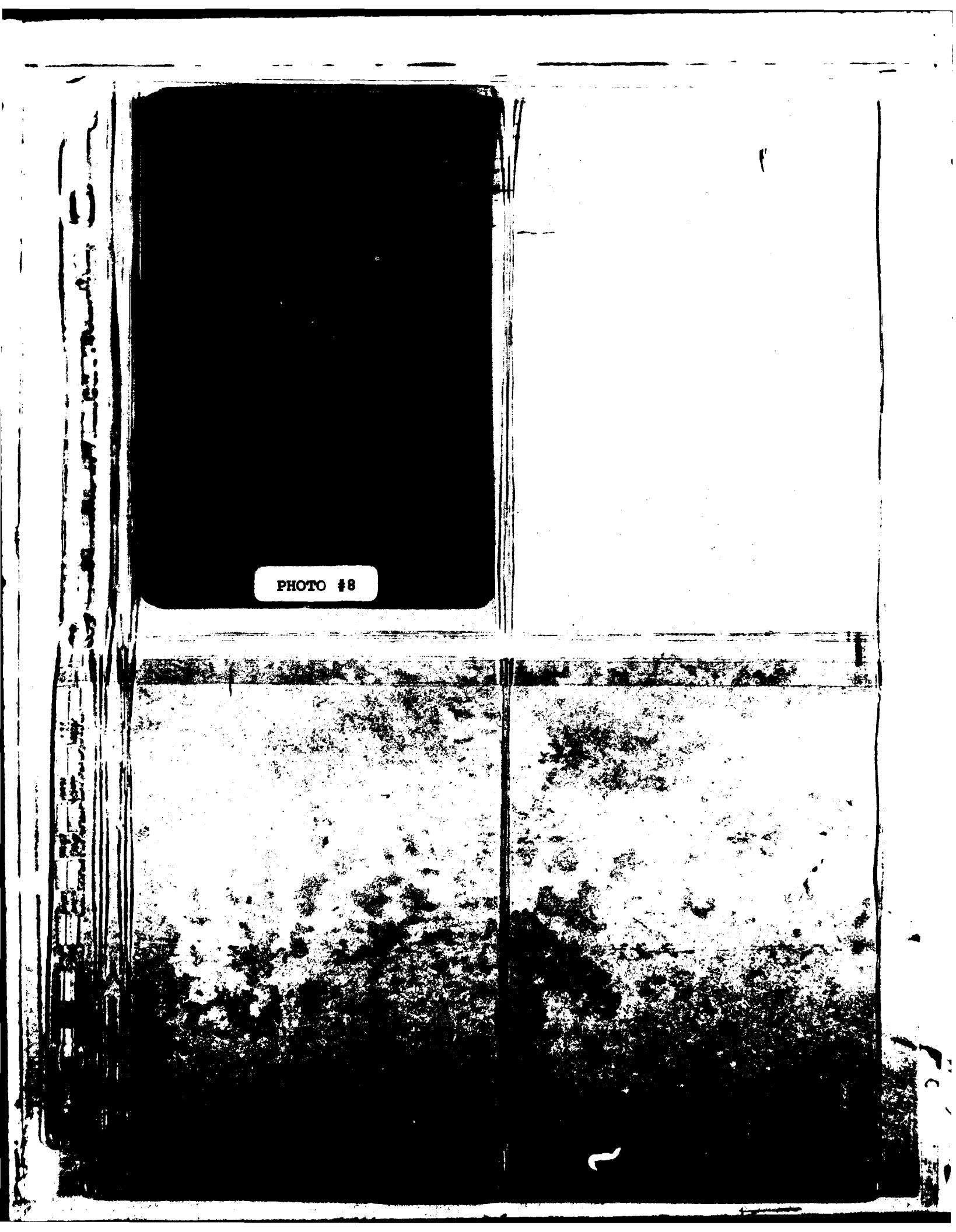
The piles in the northern half of the pier were in better overall condition, with only 5% displaying cracking up to 1/8" in width. However, one pile had a 1/2" wide crack, 1" deep, from the pile cap down 3 feet (no reinforcing exposed), and three piles were spalled up to 3" deep on one or two faces within 2 feet of the pile cap, exposing steel reinforcing.

Nine piles from Bents 1 to 19 exhibited spalling, up to 3" deep, on up to two corners or faces within 3 feet of the pile cap. Six of the nine piles had reinforcing exposed. The remainder of the piles had occasional cosmetic spalling on the corners.

Soundings along the perimeter of the pier ranged from -46.0' to -20.0' below MLW on the north face and -40.0' below MLW to +5.0' above MLW on the south face.

PHOTO #8: Cracking and Spalling Around Pile
Head and Cap, Exposing Reinforcing
(Pier PAPA)

PHOTO #8



4.5.3 Structural Condition Assessment

Pier PAPA is in good condition. No structural anomalies were observed to cause this pier to be downgraded. As for many concrete piles of similar age, cracking and spalling of the concrete was the most common deterioration recorded. Although generally not a structural problem, minor cracking and spalling allow salt water to enter the pile. This ingress of water often hastens deterioration. Repairs to stop this continuing infiltration of water are the only solution.

4.5.4 Recommendations

It is recommended that all cracks greater than 1/32" in width and spalled areas deeper than 1" be filled with an epoxy grout. Before filling, these areas should be chipped and replaced, if necessary. The estimated cost to repair this pier is \$51,000.

4.6 PIER QUEBEC

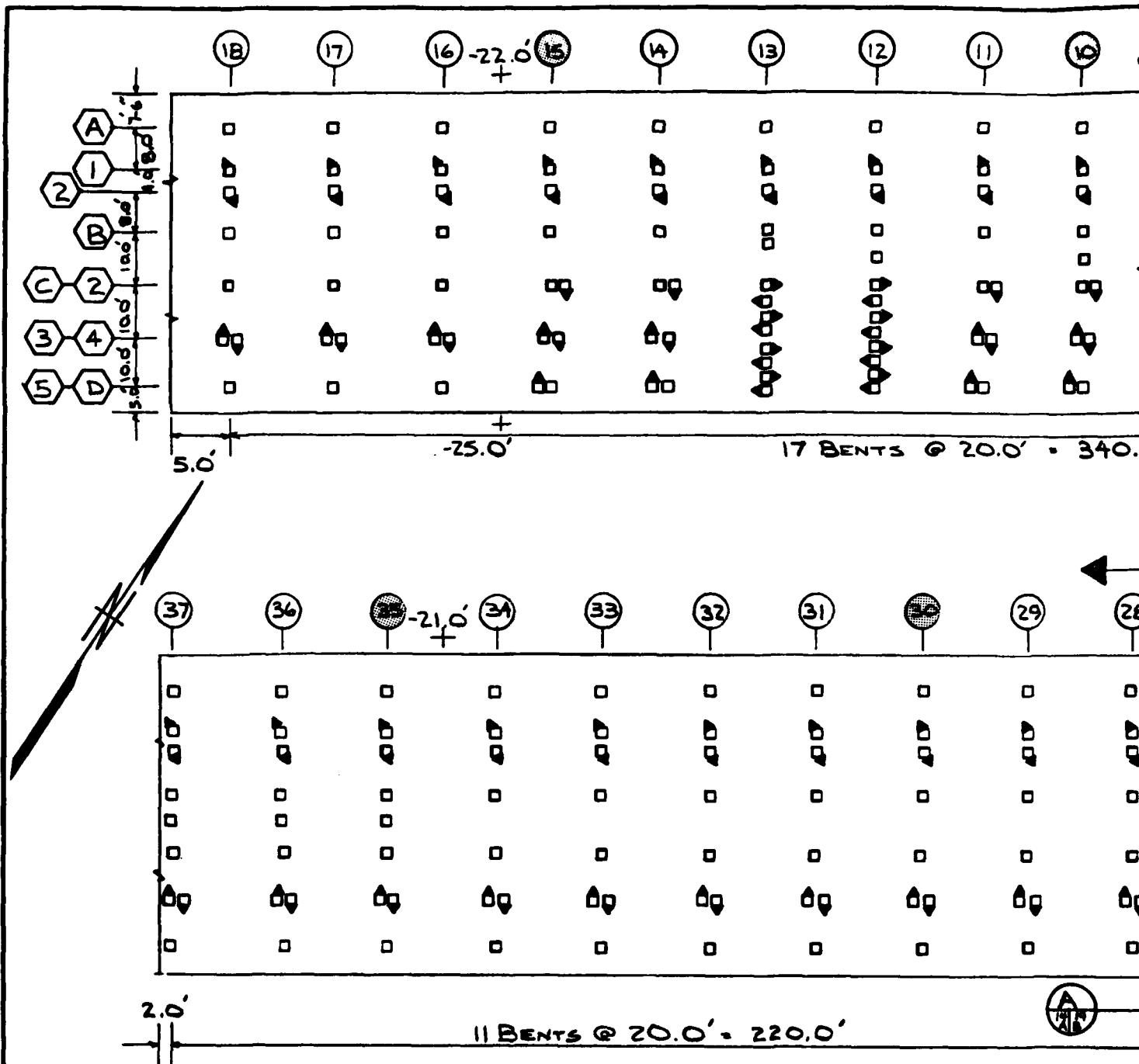
4.6.1 Description

Pier QUEBEC is situated on the west bank of the Cooper River, just north of Pier ROMEO and just south of Pier PAPA. The pier provides berthing for up to five frigates (FF), guided missile equipped frigates (FFG) or transient ships.

Pier QUEBEC was built around 1946 and widened in 1965. The 1036' long x 60' wide pier has a reinforced concrete deck supported by 53 bents of 18" square precast, reinforced concrete piles (see Figures 14A and 14B). The northern half of the pier was built in 1965 and contains 98 batter and 122 vertical bearing piles. These piles are prestressed concrete and designed for a 75-ton allowable load. The new decking was designed for a live load of 500 PSF uniform loading or H-20 truck loading with 15% impact. The southern half of the pier is older and probably the original 1946 structure. It is supported by 150 batter and 100 vertical bearing piles which were originally designed for a minimum bearing capacity of 50 tons. The older decking was designed for a live load of 300 PSF uniform load or H-15 loading plus 15% impact.

References: Naval Shipyard, Charleston, S.C.
"Facilities for Inactive Vessels -
Piers Nos. 1 to 6"
P.W. Dwg. #H325-3 and #H325-4

Southeast Division, Bureau of Yards and Docks
"Berthing Facilities - 3rd Increment"
Y&D Dwg. #1080528 and #1080531



LEGEND

(1) - BENT NO.

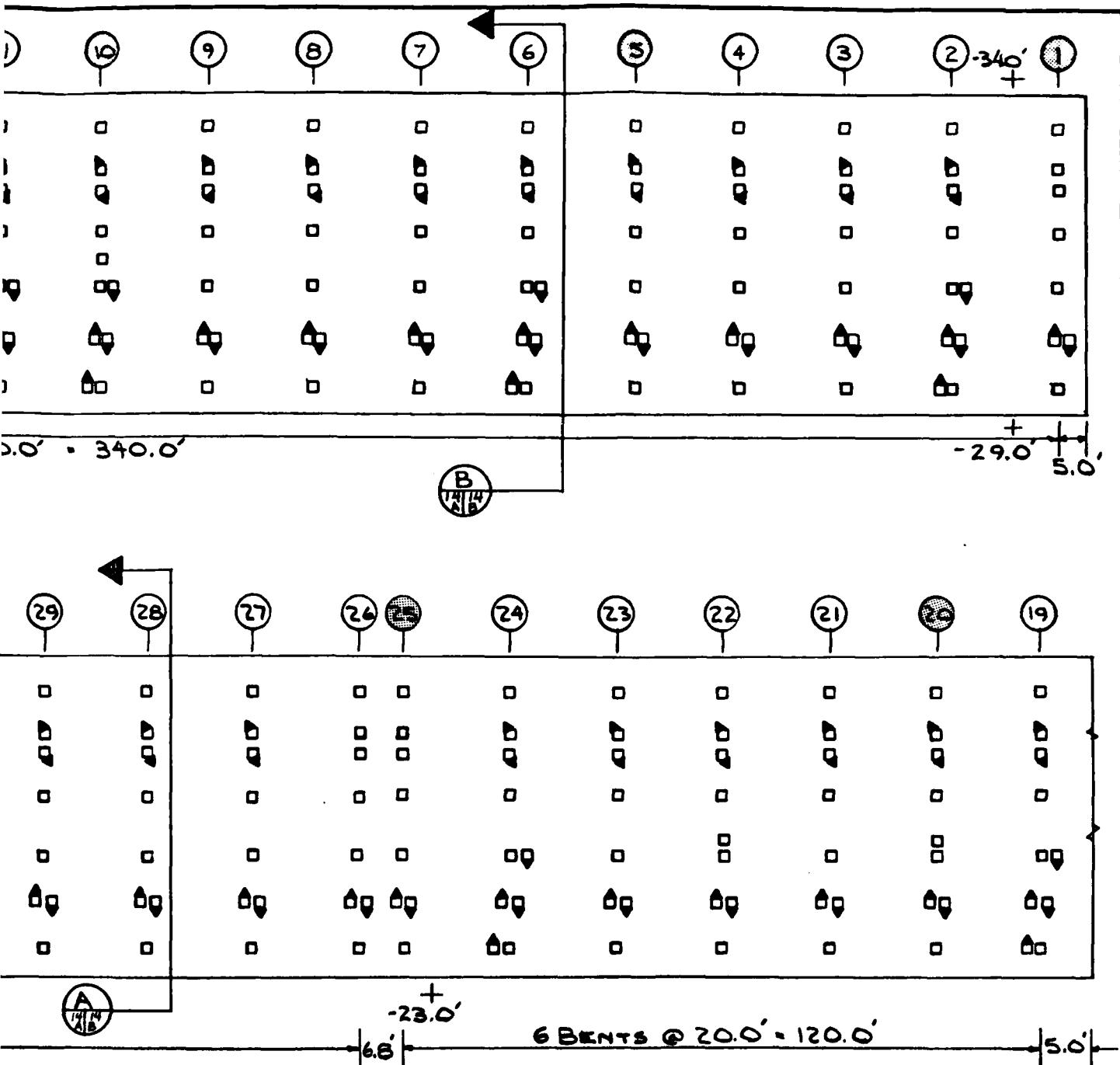
(2) - PILE DESIGNATION (VERTICAL)

(3) - PILE DESIGNATION (BATTERED)

+ 21.0 SOUNDING (MLW)

(1) - CLOSELY INSPECTED BENT. REMAINING BENTS GIVEN CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2).

PL

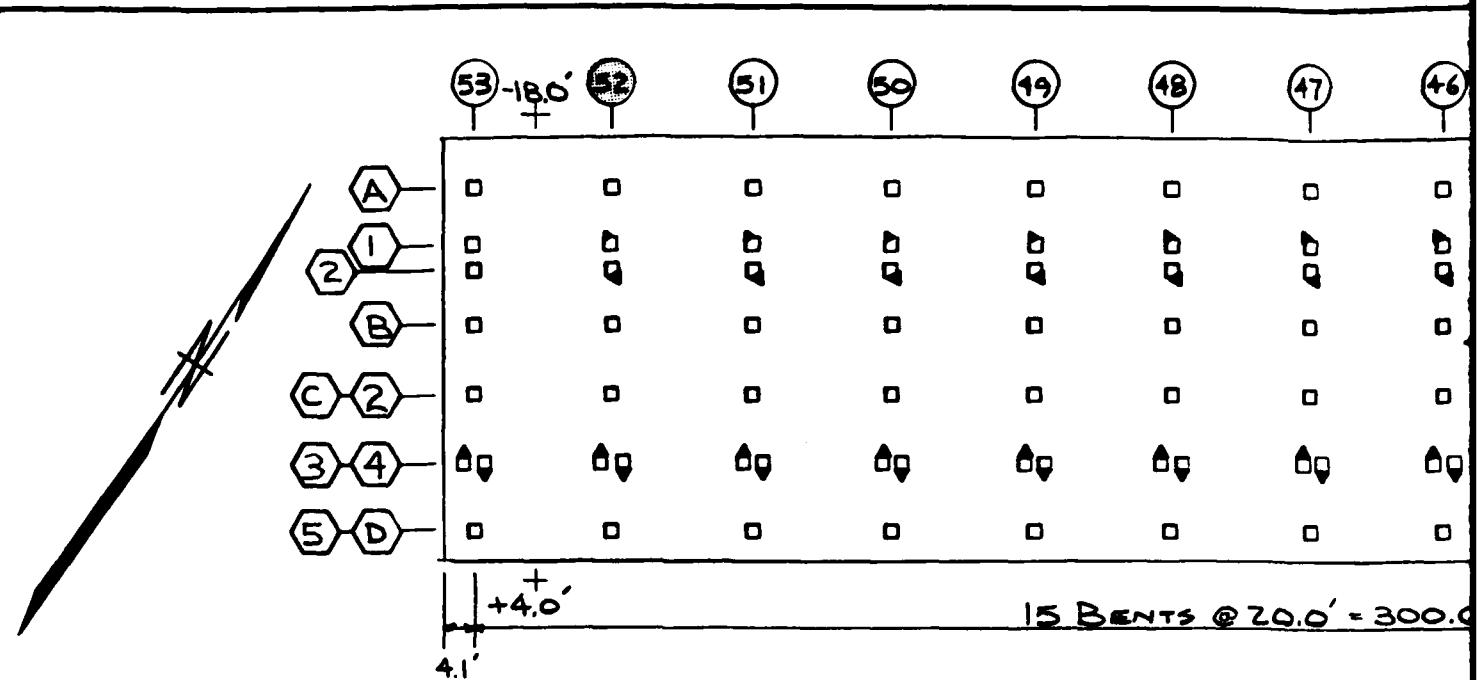


N-
A-
.2).

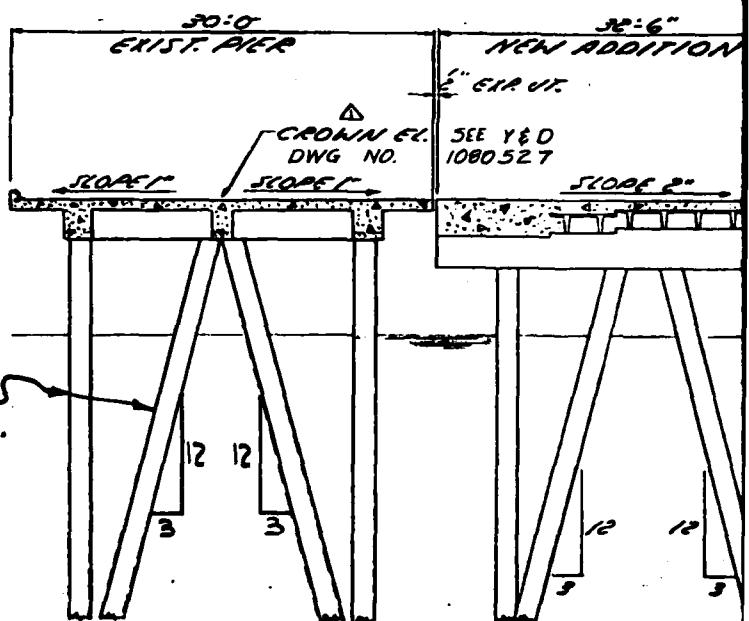
PLAN

2 NOTE: BENT AND PILE DESIGNATIONS ARE ACCORDING
TO CHESDIV STANDARDS.

GRAPHIC SCALE	CH2M Engineering Corporation One 500 Morris, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL STATION CHARLESTON, SC PIER QUEBEC
5'0 10' 20' 30' 40'		PR. NO. 14A



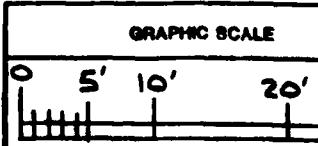
15 BENTS @ 20.0' = 300.0'

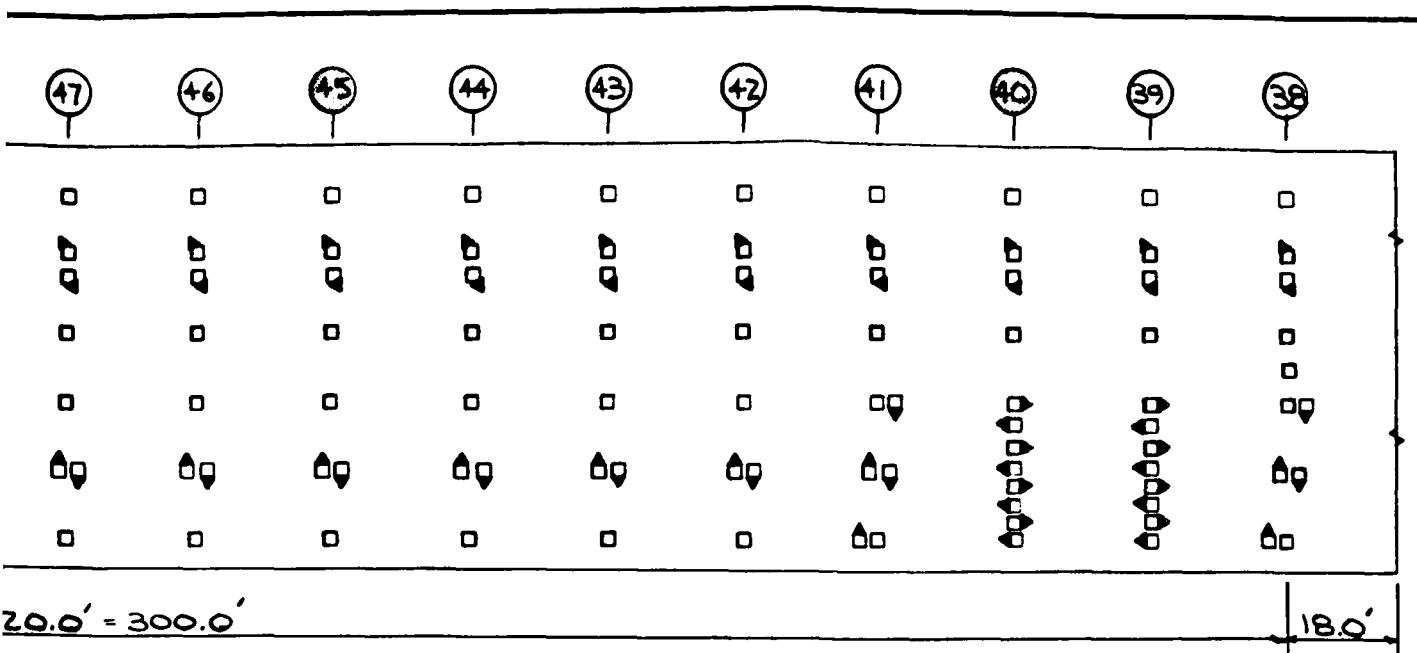


LEGEND

- (50) - BENT NO.
- (●) - CLOSELY INSPECTED BENT. REMAINING BENTS GIVEN CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2).
- (C) - PILE DESIGNATION (VERTICAL)
- (2) - PILE DESIGNATION (BATTERED)
- 20.0' Sounding (MLW)

NOTE: BENT AND PILE DESIGNATIONS ARE ACCORDING TO CHESDIV STANDARDS.

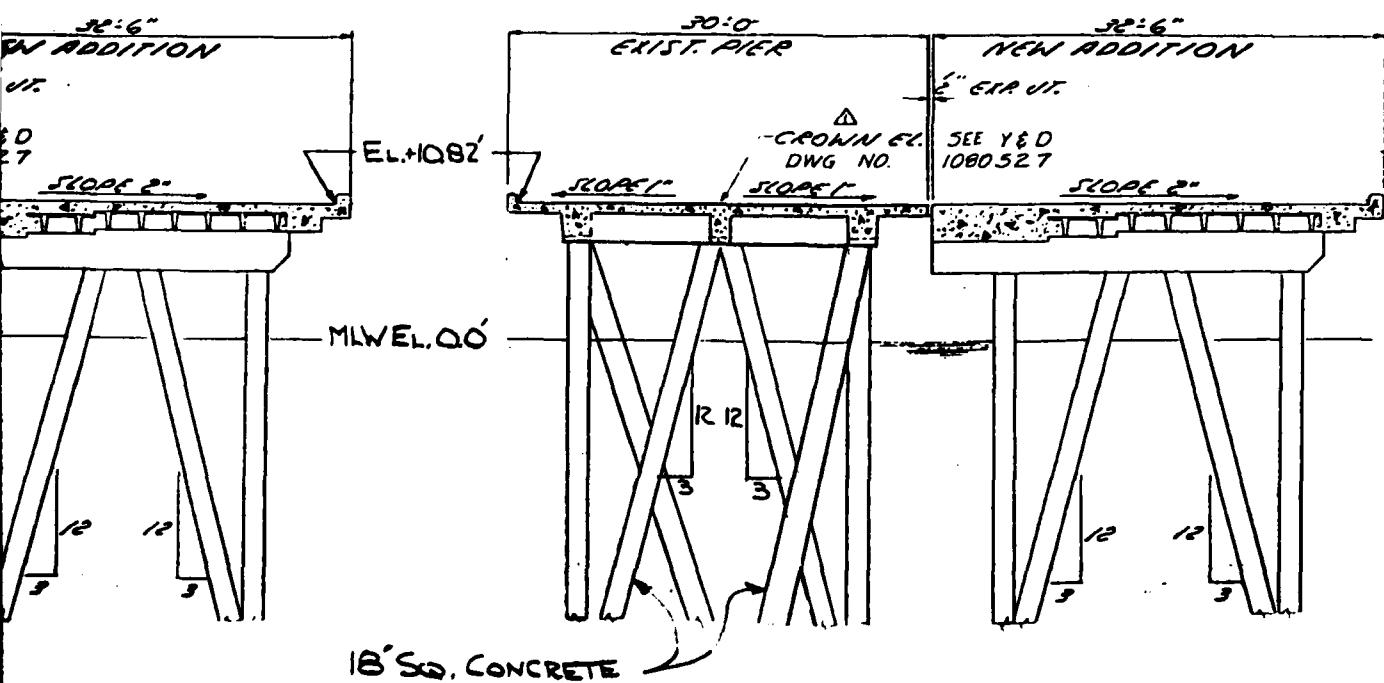




$$\underline{20.0' = 300.0'}$$

18.0

PLAN



**1B' Sq. CONCRETE
PILE (TYP.)**

2

SECTION

B
14/19
AB

GRAPHIC SCALE	GRAPHIC SCALE	CHM&S Engineering Corporation 801 3rd Avenue, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.
10' 20' 30' 	5' 0 10' 20' 30' 40' 	NAVAL STATION CHARLESTON, SC	POL. NO. PIER QUEBEC 14B

4.6.2 Observed Inspection Condition

On the northern half of the pier, approximately 5% of the piles had hairline cracks around mean low water (MLW).

From Bents 26 to 45, around 20% of the piles had one or two 1/8" wide cracks running from 2 feet below the pile cap to mudline. No rusting or reinforcing was visible. There was occasional cosmetic spalling on the corners.

The piles in the southern portion of the pier generally had 1/2" of softness and cracking (from hairline to 1/16" in width, 2 - 3 feet in length) around MLW. Approximately 40% of the piles had 1/8" - 1/4" wide cracks on one corner, along with spalling and 1/2" - 1" of softness (see Photo #9). One pile had a 3/8" wide crack on a corner running from MLW to El. +3.0' with 2" - 3" of softness around it, but no reinforcing was exposed (Bent 41, Pile 4). Around 3% of the piles had spalling deeper than 1" (maximum of 5" deep), usually on a corner in the area from MLW to +3.0'. No reinforcing was exposed, however.

Soundings along the perimeter of the pier ranged from -18.0' to -34.0' below MLW on the northern face and +4.0' above MLW to -29.0' below MLW on the southern face.

PHOTO #9: Typical Cracking (Maximum 1/4" Wide), Spalling and Softness of Concrete on a Corner Around Mean Low Water (Pier QUEBEC)

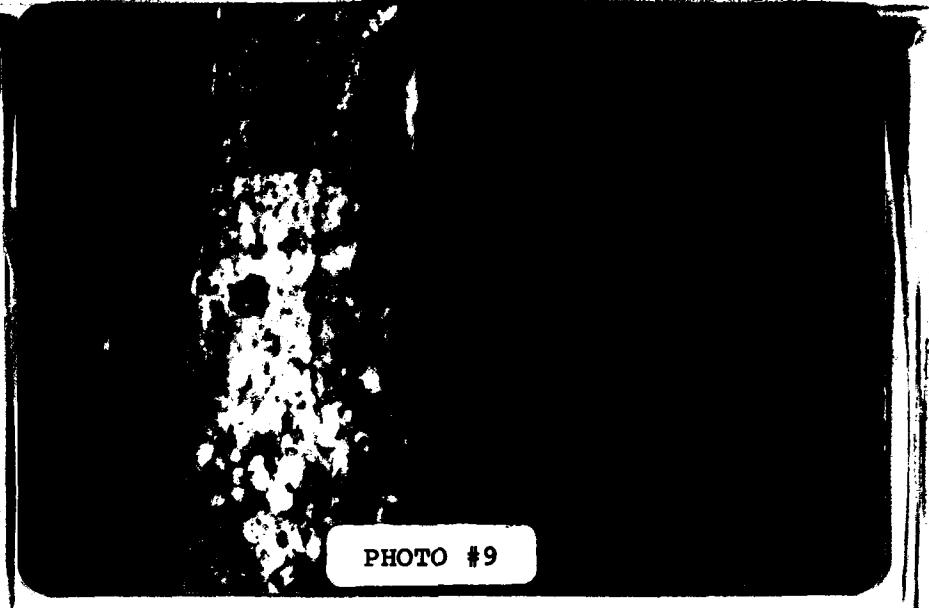


PHOTO #9



4.6.3 Structural Condition Assessment

Pier QUEBEC is in good condition. No structural anomalies were observed to cause this pier to be downgraded.

Cracks and spalling were the only conditions observed that could cause a problem in the future. Water entering through these openings can corrode the steel reinforcing and/or freeze and expand. This causes the concrete cover to spall, allowing further ingress of salt water into the pile. Repairs to stop this infiltration are the only solution.

4.6.4 Recommendations

It is recommended that all cracks greater than 1/32" in width and spalled areas deeper than 1" be filled with an epoxy grout. The estimated cost to repair these conditions is \$58,000.

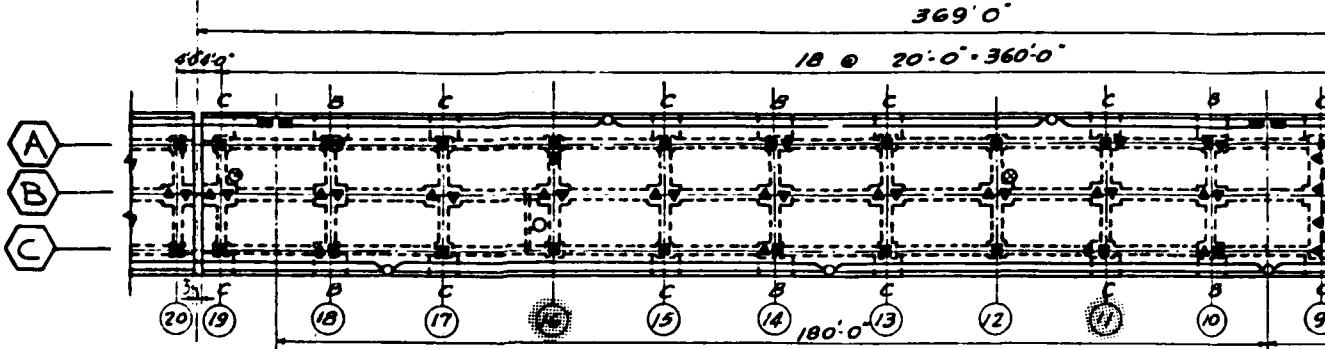
4.7 PIER ROMEO

4.7.1 Description

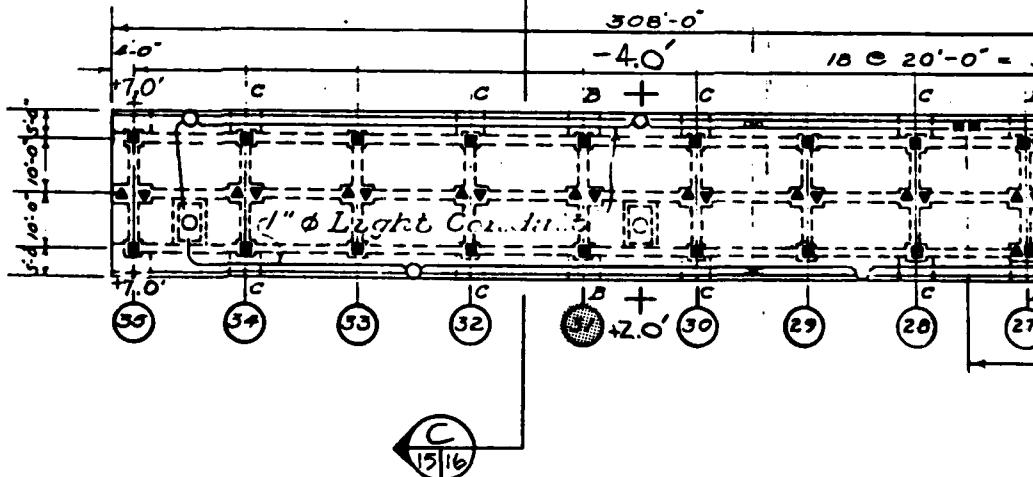
Pier ROMEO lies on the west bank of the Cooper River between Piers QUEBEC to the north and SIERRA to the south. It can accommodate a variable number of support and service craft, notably harbor tugboats.

Pier ROMEO was built in 1946, but was rebuilt around 1970. The 677' long x 30' wide pier has a reinforced concrete deck and 35 bents of 18" square precast, reinforced concrete piles. There are a total of 112 batter and 64 vertical bearing piles (see Figures 15 and 16).

References: Naval Shipyard, Charleston, S.C.
"Facilities for Inactive Vessels -
Piers Nos. 1 to 6"
P.W. Dwg. #H325-3



A
15/16



C
15/16

LEGEND

(4) - BENT NO.

(B) - PILE DESIGNATIONS

▲ - 18" SQ. CONCRETE PILE (BATTERED)

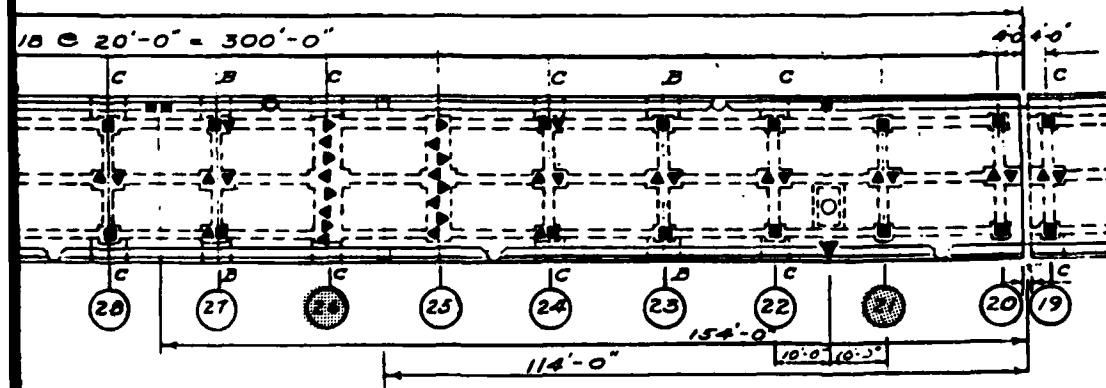
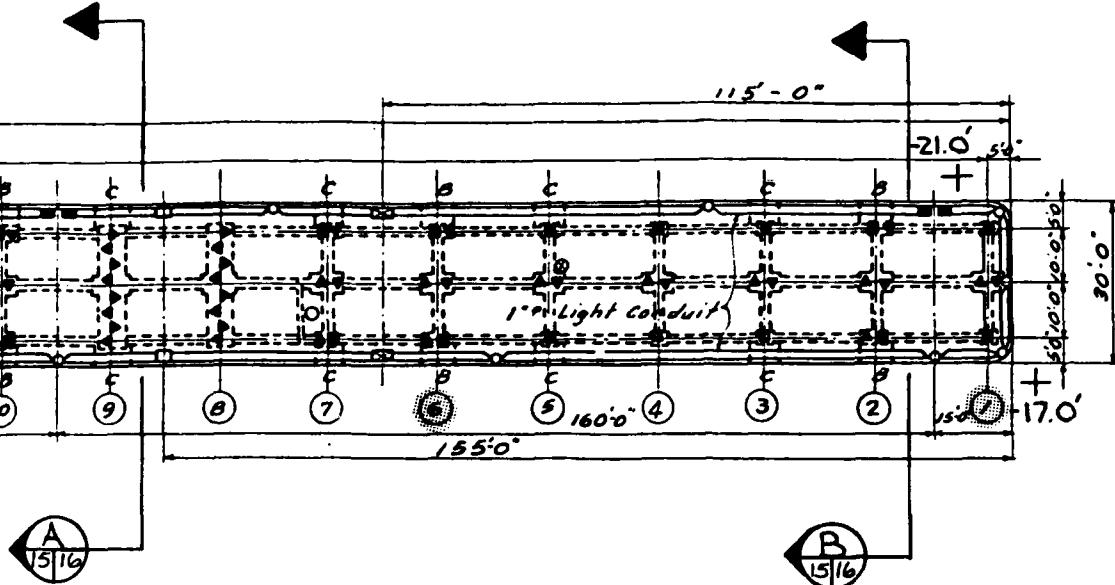
■ - 18" SQ. CONCRETE PILE (VERTICAL)

/ - 25'

+ - SOUNDING (BELOW MEAN LOW WATER)

PLA

(C) - CLOSELY INSPECTED BENT. REMAINING BENTS GIVEN CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2).



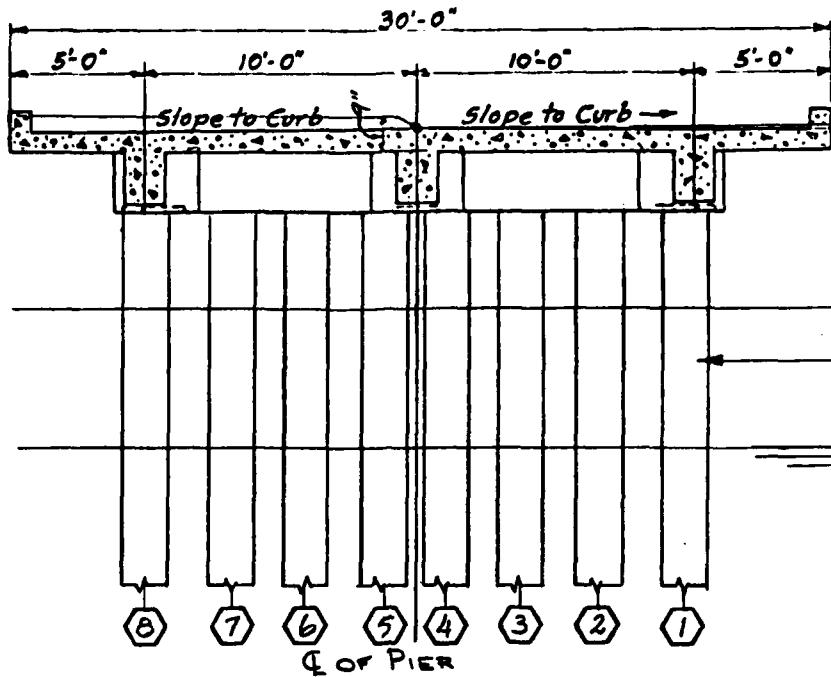
PLAN

2

NOTE: FROM Y&D DWGS. NO. 426,217 AND 395,722
PIERS NOS. 1 TO 6

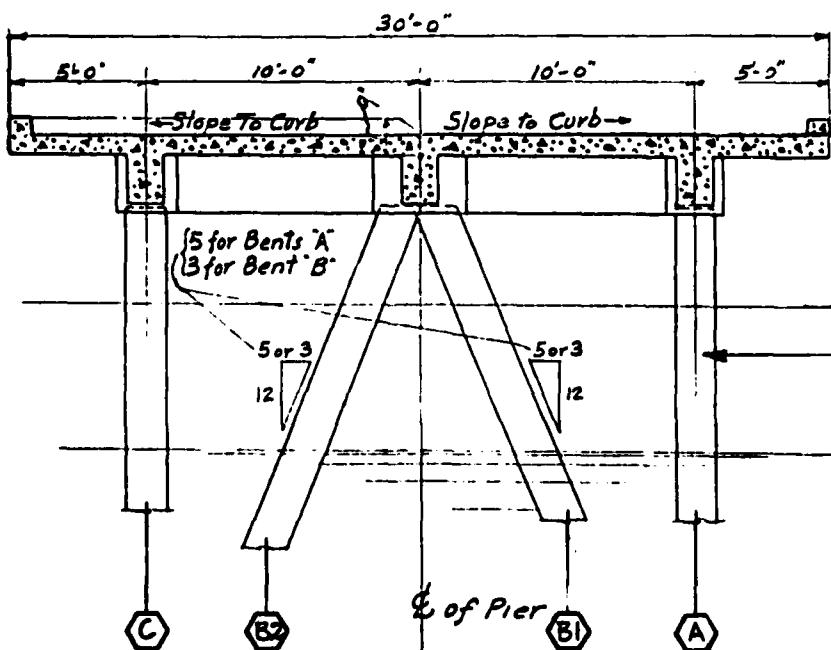
ED BENT. REMAINING
CURSORY "SWIM-BY"
(SECTION 3.2).

GRAPHIC SCALE	Childs Engineering Corporation Box 283 Woburn, MA	CHESAPEAKE DIVISION
		NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.
0 10' 20' 40' 60'	NAVAL STATION CHARLESTON, SC	P.I.D. NO. 15
PIER ROMEO		



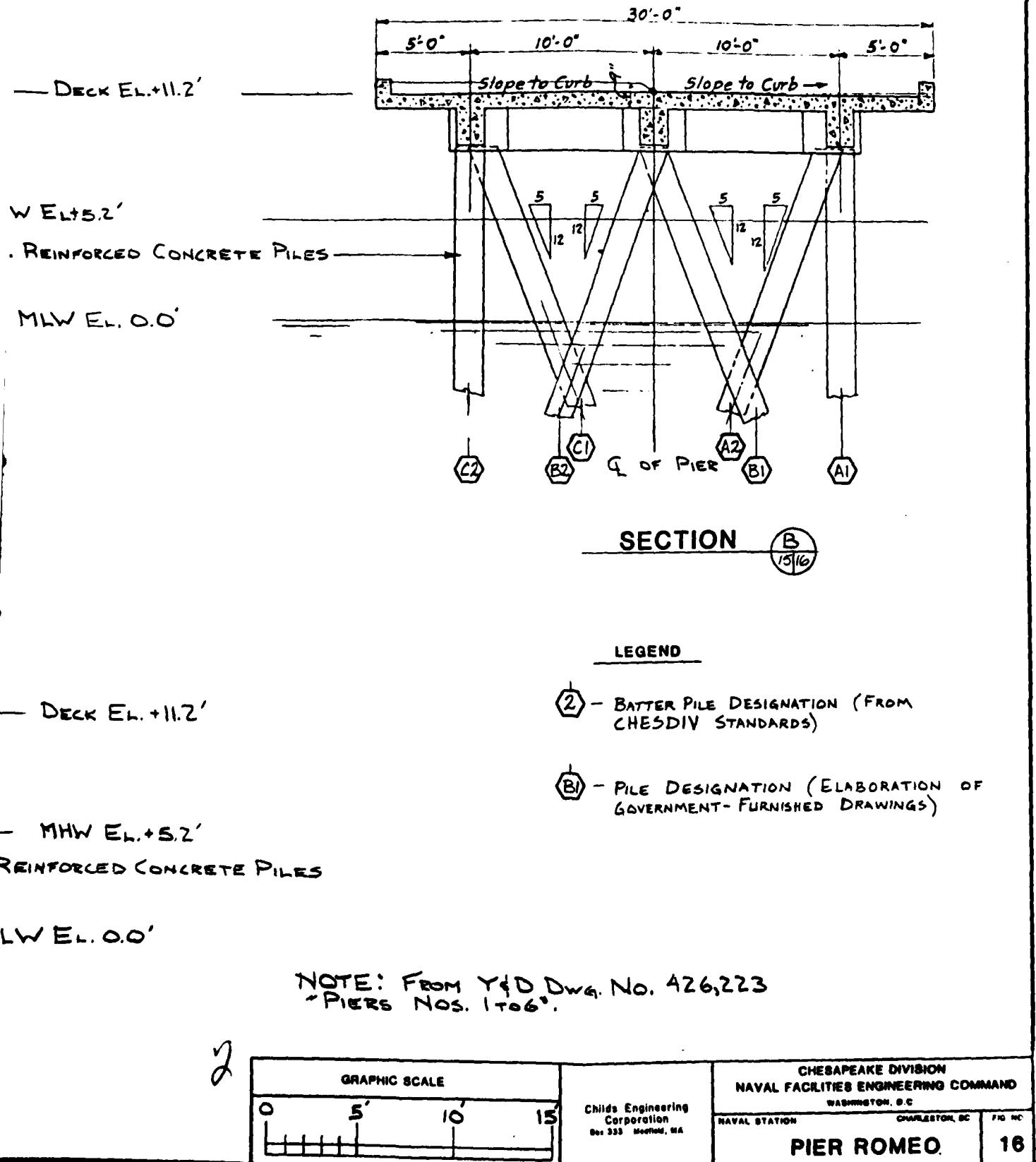
SECTION

(15/16)



SECTION

(15/16)



4.7.2 Observed Inspection Condition

Generally, all the piles in Pier ROMEO had cracks up to 1/16" in width running from near the pile cap down to mean low water (MLW). Around 40%, however, had cracks up to 1/4" wide. Spalling and 1" - 2" of softness were common in the areas of cracking (see Photo #10). In the MLW area, there was generally 1/2" of softness in the concrete.

About 5% of the piles evidenced more severe spalling (2" - 6" deep) in the region from the pile cap to MLW (see Photo #11). The concrete was soft in areas of spalling (1" deep). Half of these piles had reinforcing exposed. All these piles were located on the inshore perimeter of the pier (from Bents 26 to 35).

Soundings along the perimeter of the pier ranged from +7.0' above MLW inshore to -21.0' below MLW on the outshore northern face and -17.0' below MLW on the outshore southern face.

PHOTO #10: Example of Cracking
(Maximum 1/4" Wide),
Spalling and Softness
of Concrete Around
Mean Low Water (Pier
ROMEO)

PHOTO #11: Severe Spalling (Maximum
6" Deep) Around Mean Low
Water at Pier ROMEO (Bent
#30, Pile C)

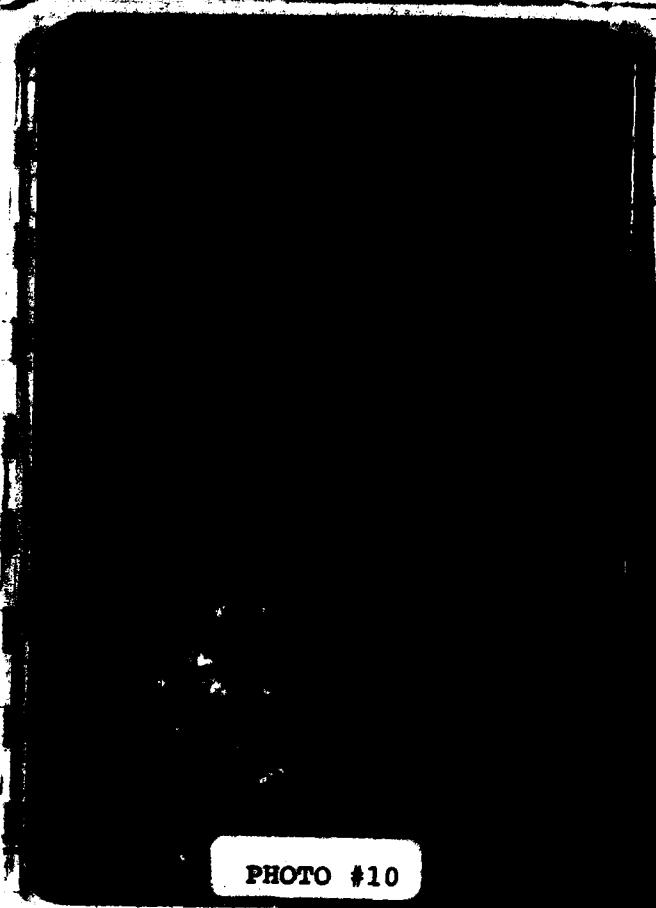


PHOTO #10

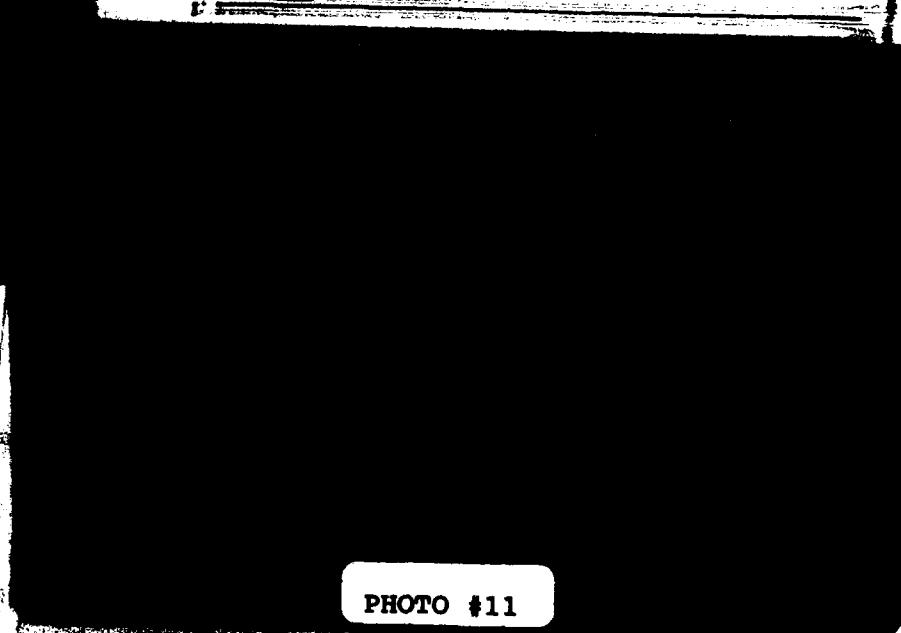


PHOTO #11

4.7.3 Structural Condition Assessment

Pier ROMEO is in good condition except for some areas of heavy spalling on various exterior piles in Bents 1 to 10. This localized heavy spalling is probably due to the location of these piles since they are completely exposed at low tide and are prone to impact damage. Air temperatures are more variable and have greater extremes than water temperatures. Therefore, during cold weather, any water inside the pile is more apt to freeze when the pile is exposed to air temperatures. The result is spalling and cracking of the concrete which can shorten the expected life of these piles. Repairs to protect concrete piles from further deterioration is the best solution.

4.7.4 Recommendations

It is recommended that all cracks greater than 1/32" wide and all spalled areas greater than 1" deep be repaired to protect them from further deterioration. The estimated cost for these repairs is \$36,000.

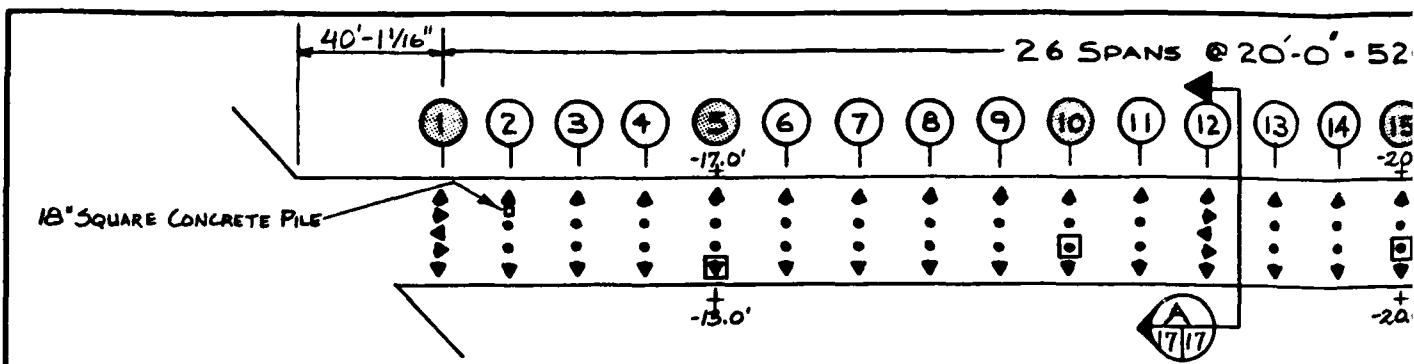
4.8 PIER SIERRA

4.8.1 Description

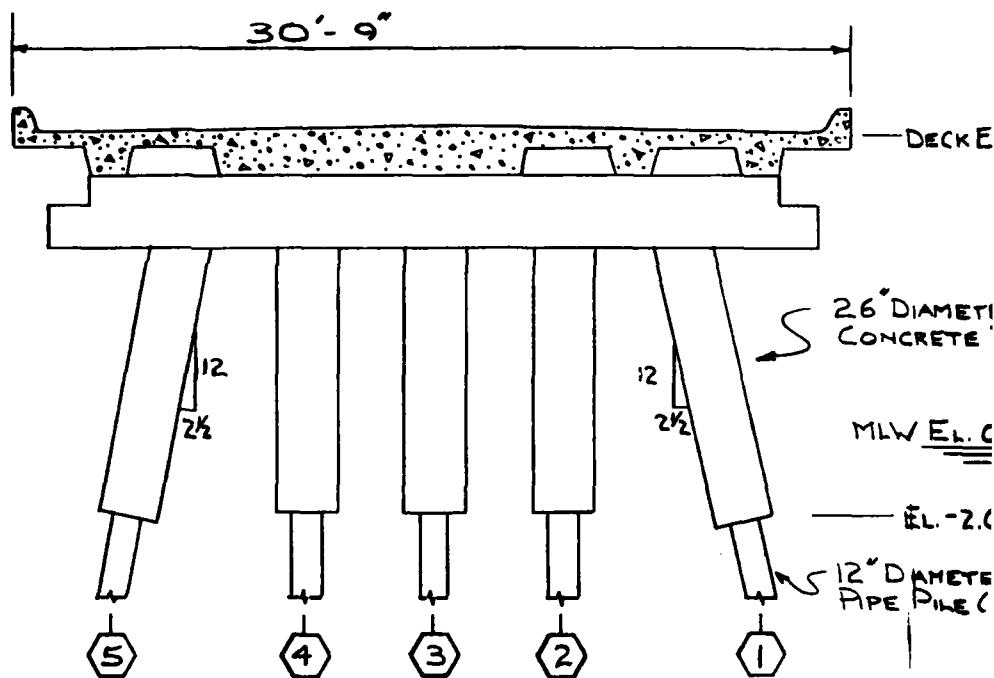
Located on the west bank of the Cooper River, Pier SIERRA lies between Pier ROMEO to the north and Pier TANGO to the south. It provides berthing for up to two destroyers (DD) and one frigate (FF).

Pier SIERRA was built around 1956. The reinforced concrete deck is supported by 27 bents of concrete-jacketed steel pipe piles (see Figure 17). The piles are 12" in diameter and the jackets, which run from the pile cap down to El. -2.0', are 2.2 feet in diameter. There are a total of 63 batter and 48 vertical bearing piles. The 521' long x 31' wide pier runs in a northeasterly direction from land, making an angle of 48° with the downstream shoreline. The deck was designed to handle a live load of 400 PSF or H-15 truck loading plus 15% impact.

References: Bureau of Yards and Docks
"Waterfront Facilities & Utilities - Piers
& Quaywall - Plan of Piers 8, 9 & 10"
Y&D Dwg. #692625



PLAN



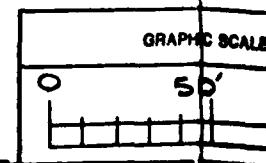
LEGEND

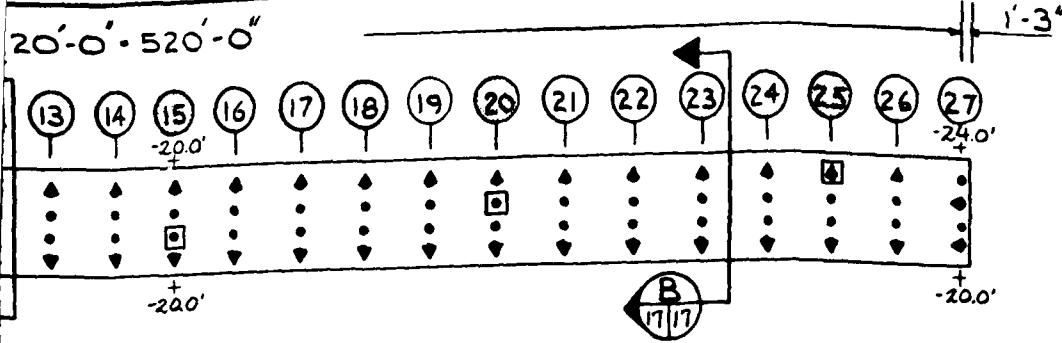
- (4) - PILE DESIGNATION (BATTERED)
 - - 12" DIAMETER STEEL PIPE PILE (VERTICAL)
 - ▼ - 12" DIAMETER STEEL PIPE PILE (BATTERED)
- (2) - BENT NO.
- 20.0' + - SOUNDING (BELOW MEAN LOW WATER)
- (A) - PILE DESIGNATION (VERTICAL)

SECTION

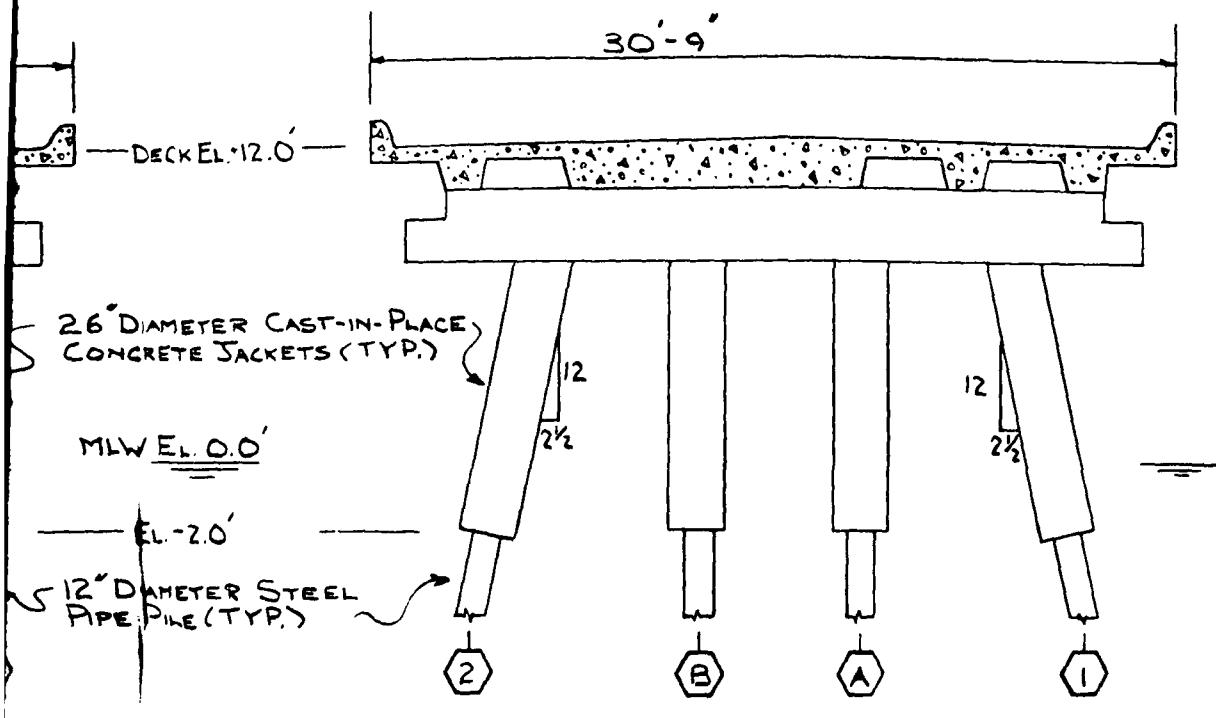


- - CLOSELY INSPECTED BENT GIVEN CURSORY "SWIM-1"
- - METAL THICKNESS READIN





PLAN



SECTION B

LY INSPECTED BENT. REMAINING BENTS CURSORY "SWIM-BY" INSPECTION (SEE SECTION 3.2).

THICKNESS READINGS TAKEN (SEE APPENDIX)

NOTE: BENT AND PILE DESIGNATIONS ARE ACCORDING TO CHESDIV STANDARDS.

GRAPHIC SCALE	GRAPHIC SCALE	Childs Engineering Corporation Box 333 Boston, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.
50' 100'	0 5' 10' 15'	NAVAL STATION CHARLESTON, SC	FIG NO. PIER SIERRA 17

AD-A168 188

22
UNDERWATER FACILITIES INSPECTIONS AND ASSESSMENTS AT
NAVAL STATION CHARLE. . (U) NAVAL FACILITIES ENGINEERING
COMMAND WASHINGTON DC CHESAPEAKE.. MAY 81

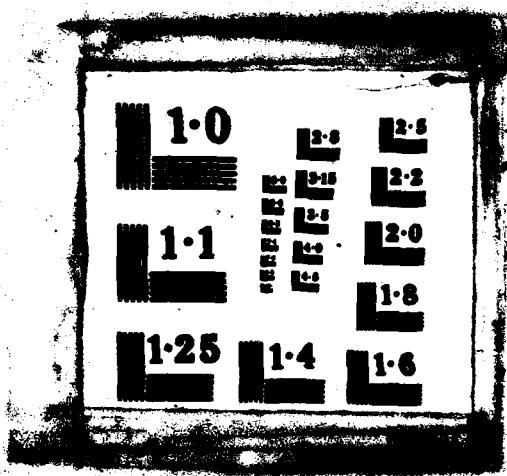
CFSC/NAVFAC-EDO-1-81/1a)

UNCLASSIFIED

F/A 19/2

M1

END
DATE
FILED
5-86



4.8.2 Observed Inspection Condition

The only damage observed occurred in Bent 2. The concrete jacket on Pile 1 had a 1/2" wide horizontal crack around its circumference, 6 feet below the pile cap. There were no other signs of damage. An 18" square concrete pile had been driven just south of and adjacent to Pile 1 (see Figure 17).

Ultrasonic thickness measurements taken on five piles indicated a range in metal loss due to corrosion from 0% to 28% (see Appendix for actual thickness measurements). The steel itself was lightly pitted.

Water depths around the pier perimeter ranged from -17.0' to -24.0' below mean low water (MLW) on the north face and -13.0' to -20.0' below MLW on the south side.

4.8.3 Structural Condition Assessment

Pier SIERRA is in excellent condition. No structural deterioration has occurred to reduce the capacity of this pier. Metal loss due to corrosion is insignificant.

4.8.4 Recommendations

The crack in the concrete jacket should be filled with an epoxy grout to protect the steel pile from corrosion. The estimated cost for this repair is \$500.

No other repairs are recommended. This pier should be reinspected in 10 years using this report as a baseline. Any deterioration should be recorded and its rate should be determined.

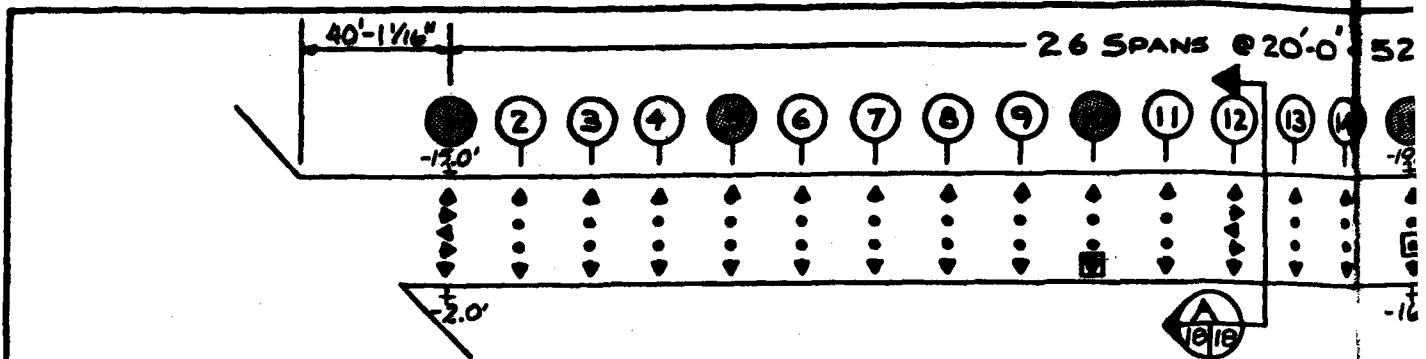
4.9 PIER TANGO

4.9.1 Description

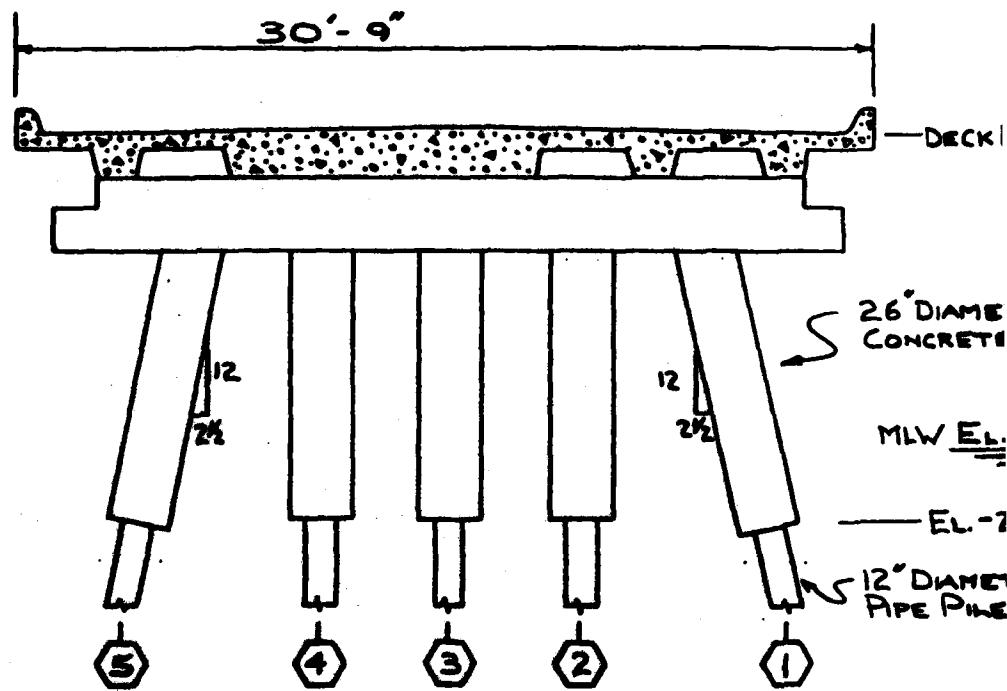
Pier TANGO is located on the west bank of the Cooper River, just south of Pier SIERRA and north of Pier UNIFORM. It can accommodate up to four destroyers (DD), mine sweepers (MSO) or special purpose ships (AG).

Pier TANGO was built around 1956. The reinforced concrete deck is supported by 27 bents of concrete-jacketed steel pipe piles (see Figure 18). The piles are 12" in diameter and the jackets, which run from the pile cap down to El. -2.0', are 2.2 feet in diameter. There are a total of 62 batter and 48 vertical bearing piles. The 521' long x 31' wide pier runs in a northeasterly direction from land, making an angle of 48° with the downstream shoreline. The deck was designed to handle a live load of 400 PSF or H-15 truck loading plus 15% impact.

References: Bureau of Yards and Docks
"Waterfront Facilities & Utilities -
Piers & Quaywalls - Plan of Piers 8, 9
& 10"
Y&D Dwg. #692625

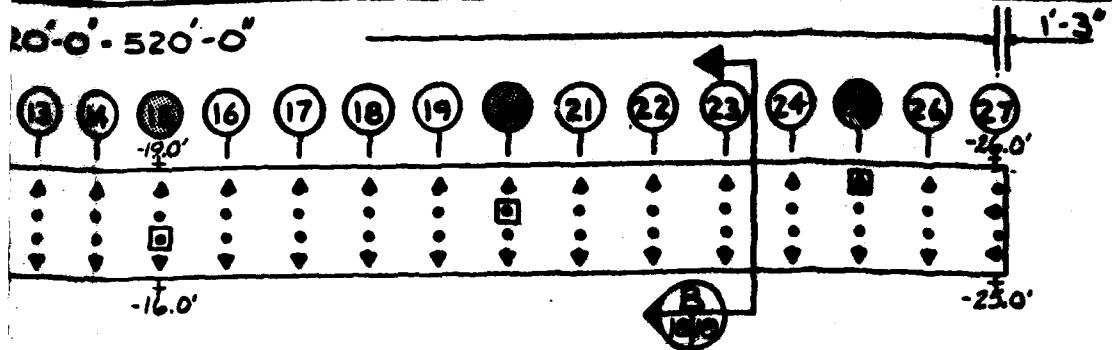


PLAN

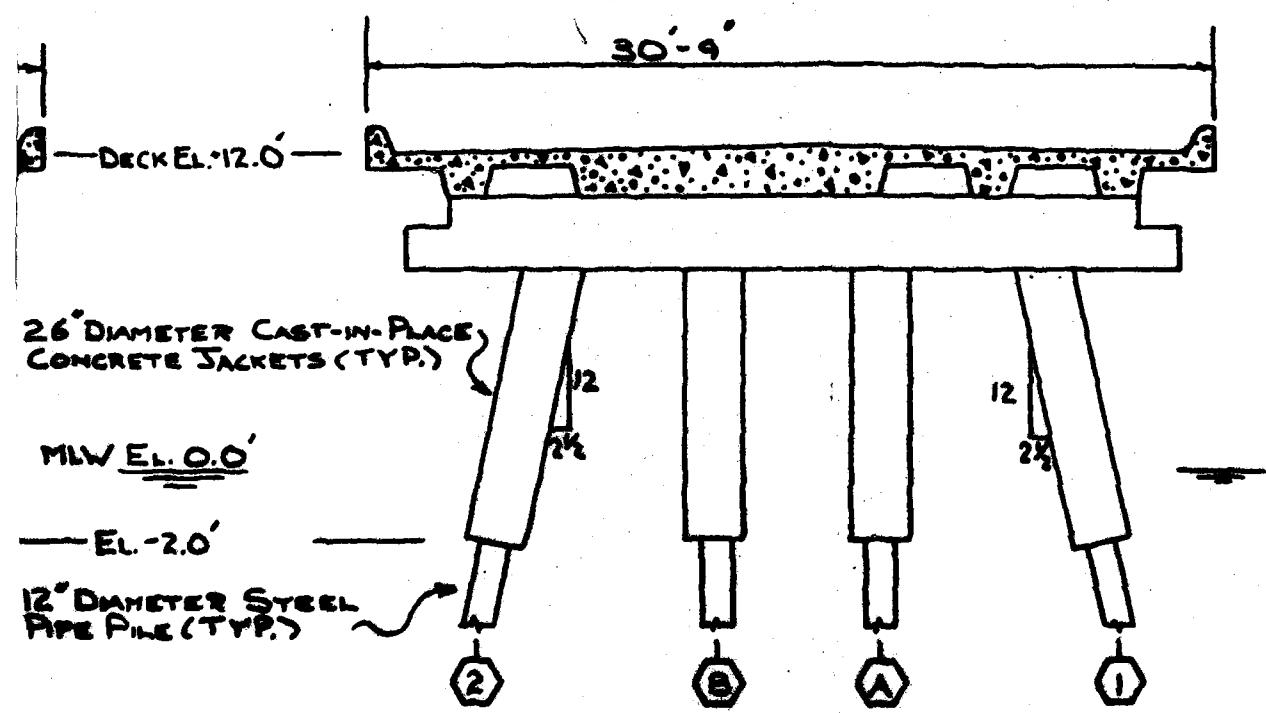


LEGEND

- | <u>SECTION</u> | A-A |
|---|--|
| (1) - PILE DESIGNATION (BATTERED) | ● - CLOSELY INSPECTED BY SURVEY "SWIM-BY" IN |
| • - 12" DIAMETER STEEL PIPE PILE (VERTICAL) | ■ - METAL THICKNESS REAC |
| ▼ - 12" DIAMETER STEEL PIPE PILE (BATTERED) | |
| (2) - BENT NO. | |
| 205 | |
| + | |
| 30' 9" | |
| (3) - PILE DESIGNATION (VERTICAL) | |



PLAN



SHORING BENT. REMAINING BENTS GIVEN
"AS-BUILT" INSPECTION (See Section 3.2).

READINGS TAKEN (See Appendix)

NOTES:

NOT ACCORDING

SECTION ————— P
100

4.9.2 Observed Inspection Condition

No damage was observed at Pier TANGO. Ultrasonic thickness measurements taken on four piles indicated a range in metal loss due to corrosion from 13% to 29% (see Appendix for actual thickness measurements). The steel itself was lightly pitted.

Water depths around the pier perimeter ranged from -15.0' to -26.0' below mean low water (MLW) on the north side and -2.0' to -25.0' below MLW on the south side.

4.9.3 Structural Condition Assessment

Pier TANGO is in excellent condition. Metal loss due to corrosion is insignificant. The concrete jackets still appear to be protecting the piles from corrosion.

4.9.4 Recommendations

No repairs are recommended for Pier TANGO. This pier should be reinspected in 10 years using this report as a baseline. Any further deterioration should be recorded and its rate should be determined.

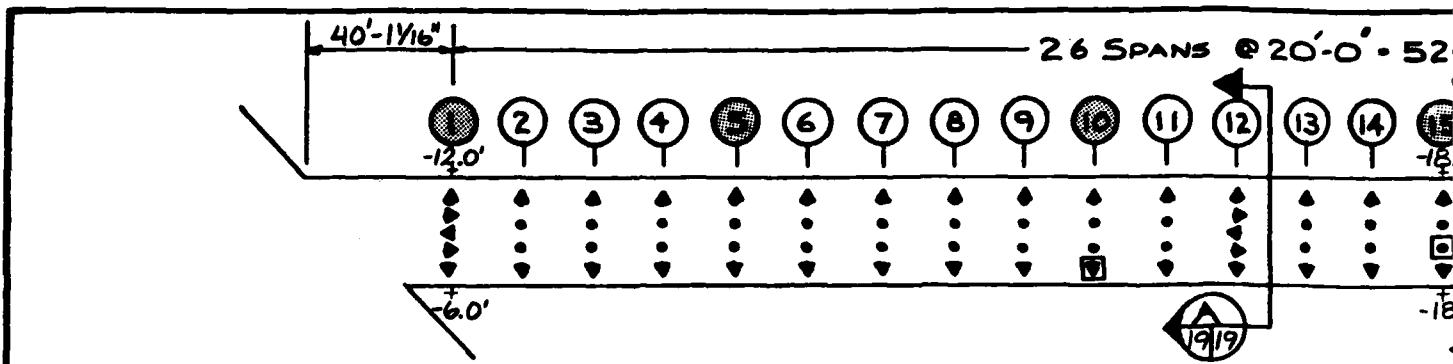
4.10 PIER UNIFORM

4.10.1 Description

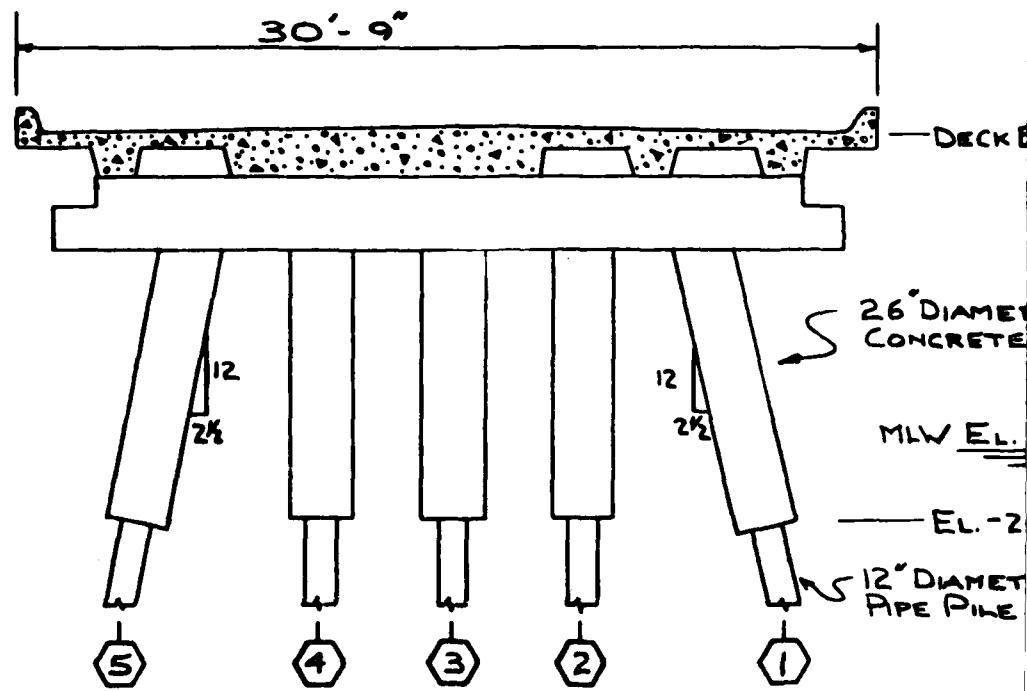
Situated on the west bank of the Cooper River, Pier UNIFORM lies between Pier TANGO to the north and floating Pier VICTOR to the south. It functions as a berthing area for up to four mine sweepers (MSO) or special purpose ships (AG).

Pier UNIFORM was built around 1956. The reinforced concrete deck is supported by 27 bents of concrete-jacketed steel pipe piles (see Figure 19). The piles are 12" in diameter and the jackets, which run from the pile cap down to El. -2.0', are 2.2 feet in diameter. There are a total of 62 batter and 48 vertical bearing piles. The 521' long x 31' wide pier runs in a northeasterly direction from land, making an angle of 63° with the downstream shoreline. The deck was designed to handle a live load of 400 PSF or H-15 truck loading plus 15% impact.

References: Bureau of Yards and Docks
"Waterfront Facilities and Utilities -
Piers & Quaywalls - Plan of Piers 8, 9
& 10"
Y&D Dwg. #692625



PLAN



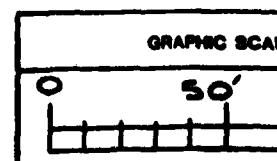
LEGEND

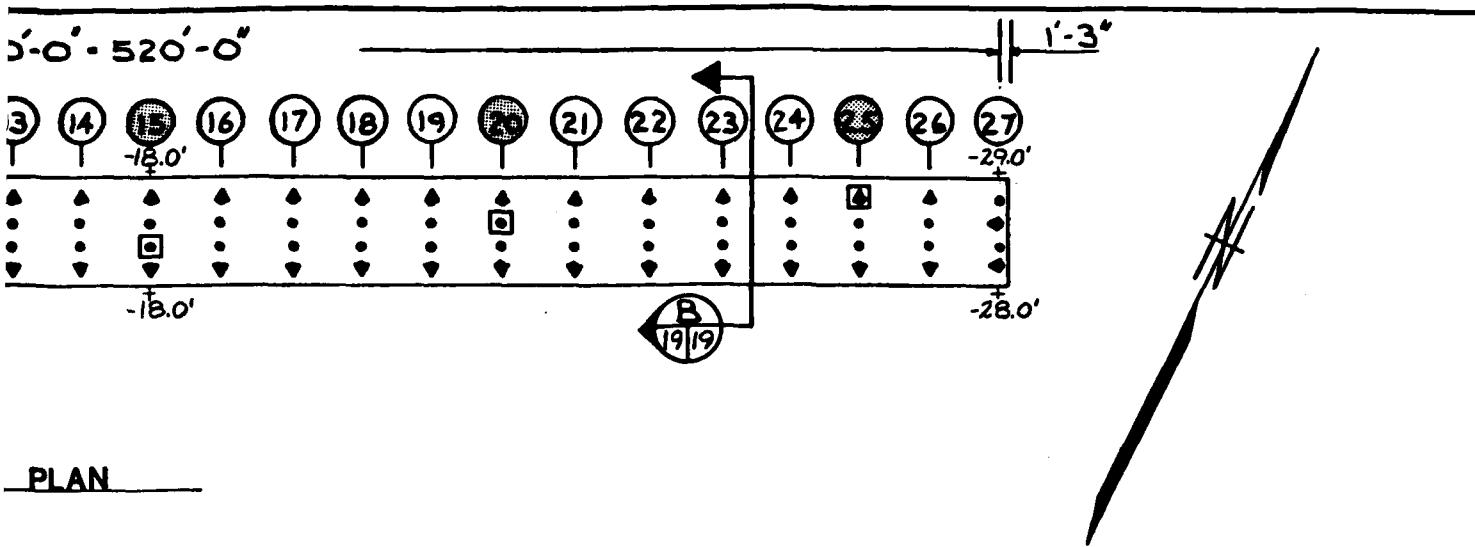
- ④ - PILE DESIGNATION (BATTERED)
 - - 12" DIAMETER STEEL PIPE PILE (VERTICAL)
 - ▼ - 12" DIAMETER STEEL PIPE PILE (BATTERED)
- ② - BENT NO.
- 20.0' + - SOUNDING (BELOW MEAN LOW WATER)
- Ⓐ - PILE DESIGNATION (VERTICAL)

SECTION

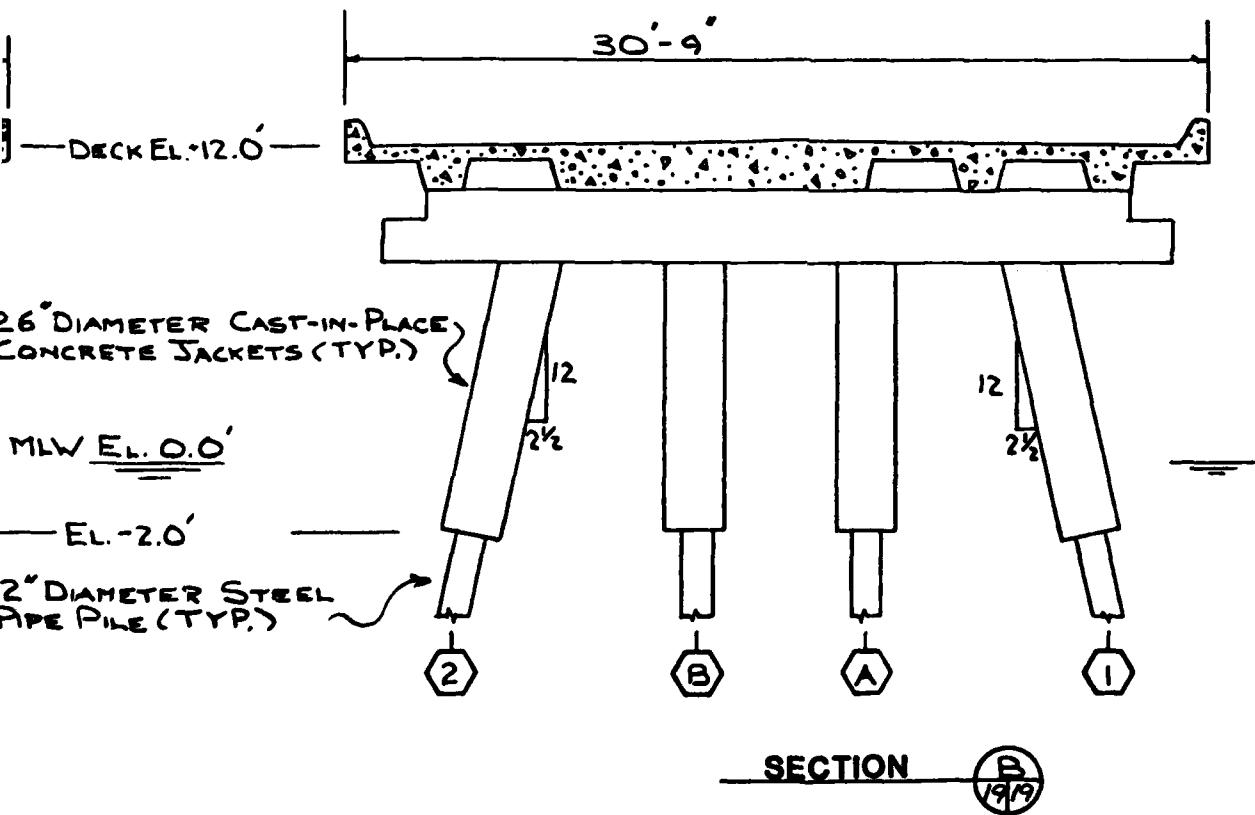
Ⓐ
1919

- Ⓐ - CLOSELY INSPECTED BENT
CURSORY "SWIM-BY" IF
- - METAL THICKNESS READ





PLAN



SECTION

B
19/19

SPECTED BENT. REMAINING BENTS GIVEN
WIM-BY" INSPECTION (SEE SECTION 3.2).

KNES READINGS TAKEN (SEE APPENDIX)

NOTE: BENT AND PILE DESIGNATIONS ARE ACCORDING
TO CHESDIV STANDARDS.

GRAPHIC SCALE	GRAPHIC SCALE	CH2O Engineering Corporation One 300 Northgate, Ga.	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL STATION CHARLESTON, SC
50' 100'	0' 5' 10' 15'		PIER UNIFORM PG. NO. 19

4.10.2 Observed Inspection Condition

In general, no damage was observed at Pier UNIFORM. Ultrasonic thickness measurements taken on four piles indicated a range in metal loss due to corrosion from 9% to 28% (see Appendix for actual thickness measurements). The steel itself was lightly pitted.

Water depths around the pier perimeter ranged from -12.0' to -29.0' below mean low water (MLW) on the north side and -6.0' to -28.0' below MLW on the south side.

4.10.3 Structural Condition Assessment

Pier UNIFORM is in excellent condition. Metal loss due to corrosion is insignificant. The concrete jackets still appear to be protecting the piles from corrosion.

4.10.4 Recommendations

No repairs are recommended for Pier UNIFORM. This pier should be reinspected in 10 years using this report as a baseline. Any further deterioration should be recorded and its rate should be determined.

TABLE OF CONTENTS FOR APPENDIX

<u>TITLE</u>	<u>PAGE</u>
Footnotes.....	A-1
Repair Cost Estimates.....	A-2
Structural Analysis Calculations.....	A-7
Thickness Measurements.....	A-9

FOOTNOTES

1. CHARLESTON NAVAL COMPLEX MASTER PLAN; Southern Division, Naval Facilities Engineering Command, p. III-17.
2. Ibid, p. III-3.
3. Ibid, p. III-3.
4. Ibid, p. III-3.
5. Ibid, p. IV-19.
6. Ibid, p. IV-20.
7. Ibid, P. II-16.
8. Ibid, p. IV-25.
9. Ibid, p. IV-25.

REPAIR COST ESTIMATE

PIER KILO

- 1) Repair cracks in concrete piles by filling cracks with
epoxy grout:

A) Chip to sound concrete, clean exposed steel and con-
crete and inject grout with high pressure pump.

$$\$40/\text{LF}^* \times 1000\text{LF of cracks} = \$40,000$$

- 2) Replace all deteriorated portions of the concrete jackets
with new 34" diameter concrete jackets.

$\$550/\text{c.y. concrete} \times .23\text{c.y./ft} \times 10\text{LF (avg)}/\text{pile} \times 17 \text{ piles (max.)}$

$$= \$21,500$$

*Costs are taken from CEC Report for U.S. Navy, Civil Engineering Laboratory, on "Survey of Techniques for Underwater Maintenance/Repair of Waterfront Structures", February 1980.

REPAIR COST ESTIMATE

PIER LIMA

- 1) Repair cracks in concrete piles by filling with
epoxy grout:

A) Chip to sound concrete, clean exposed steel (replace,
if necessary) and concrete and inject grout with high
pressure pump.

$$\$40/LF^* \times 1100LF = \$44,000$$

- 2) Patch spalled areas on piles with epoxy mortar mix:

A) Chip to sound concrete, clean exposed steel (replace,
if necessary) and concrete and patch.

$$\$15/SF^* \times 50SF = \$ 750$$

- 3) Repair damaged pile by casting new reinforced pile
section in place of damaged portion:

A) Chip to sound concrete, clean exposed steel (replace,
if necessary) and concrete and cast new 18" square
section.

$$\begin{aligned} \$550/cy \text{ concrete} \times .083\text{cy/ft} \times 14\text{LF/pile} \times 2 \text{ piles} \\ = \$ 1,300 \end{aligned}$$

- 4) Drive new reinforced 18" square concrete pile in place
of damaged pile:

Mobilization/Demobilization \$ 5,000

In-place Cost: \$2,000/pile x 2 piles \$ 4,000

Cap work: \$500/pile x 2 piles \$ 1,000

Total Cost \$10,000

*See footnote in Pier KILO's Cost Estimate

REPAIR COST ESTIMATE

PIER PAPA

1) Repair cracks in concrete piles by filling with an epoxy grout:

A) Chip to sound concrete, clean exposed steel and concrete and inject grout with high pressure pump.

\$40/LF* x 1200 LF of cracks = \$48,000

2) Patch spalled areas on piles with an epoxy mortar mix:

A) Chip to sound concrete, clean exposed steel and concrete and patch.

\$15/SF* x 200 SF = \$ 3,000

PIER QUEBEC

1) Repair cracks in concrete piles by filling with an epoxy grout:

A) Chip to sound concrete, clean exposed steel (replace, if necessary) and concrete and inject grout with a high pressure pump.

\$40/LF* x 1300 LF = \$52,000

2) Patch spalled areas on piles with an epoxy mortar mix:

A) Chip to sound concrete, clean exposed steel (replace, if necessary) and concrete and patch.

\$15/SF* x 400 SF = \$ 6,000

* See footnote in Pier KILO's Cost Estimate.

REPAIR COST ESTIMATE

PIER ROMEO

- 1) Repair cracks in concrete piles by filling with an epoxy grout:
 - A) Chip to sound concrete, clean exposed steel (replace, if necessary) and concrete and inject grout with a high pressure pump.
$$\$40/\text{LF}^* \times 700 \text{ LF} = \quad \$28,000$$

60⁹
50⁹
- 2) Patch spalled area on piles with epoxy motar mix:
 - A) Chip to sound concrete, clean exposed steel (replace, if necessary) and concrete and patch.
$$\$15/\text{SF}^* \times 150 \text{ SF} = \quad \$ 3,000$$
- 3) Encase heavily spalled piles with new 24" square reinforced concrete jackets:
 - A) Chip to sound concrete, clean exposed steel (replace, if necessary) and concrete and encase.
$$\$550/\text{c.y. concrete} \times .12\text{c.y./ft.} \times 15\text{ft. (avg)}/\text{pile} \times 5 \text{ piles}$$

$$= \quad \$ 5,000$$

*Costs are taken from CSC Report for U.S. Navy, Civil Engineering Laboratory, on "Survey of Techniques for Underwater Maintenance/Painting of Waterline Structures", February 1968.

REPAIR COST ESTIMATE

PIER SIERRA

- 1) Fill crack in concrete jacket with epoxy grout:
A) Chip to sound concrete, clean and repair.

Material	\$ 50
Labor	<u>\$450</u>
Total Cost	\$500

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MEDFIELD, MA 02052

JOB UNDERWATER FACILITY ASSESSMENT
SHEET NO. 1 OF 2
CALCULATED BY CLB DATE 6/81
CHECKED BY D.P. DATE 11/81
SCALE NAVAL STATION

PILES SIERRA, TANGO AND UNIFORM

DETERMINE PILE CAPACITY BASED ON MINIMUM RECORDED
STEEL WALL THICKNESS.

12" PIPE PILE - ORIGINAL THICKNESS .375 in.

Minimum recorded thickness = .265 in at El.-3.0'.

$$r = \frac{\sqrt{d_2^2 - d_1^2}}{4} = \frac{\sqrt{(12 - (2 \cdot 1.1))^2 - (12 - (2 \cdot .375))^2}}{4} = 4.07 \text{ in}$$

Assume l = 40 ft Fixed at both ends; k = .65

$$\sigma_{\%} = .65 \cdot 40 \text{ ft} \cdot 12 \text{ in}/\text{ft} / 4.07 \text{ in} = 76.7$$

$F_{ax} = F_y = 36 \text{ kci}$ From AISC TABLE 1-36

$$F_a = 15.69 \text{ kci}$$

Based on requirements of the Massachusetts Building
Code relating from the BOCA Book Building Code,
the maximum stresses in the steel should not exceed 1.65.

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Job Underwater Facility Assessments
SHEET NO. 7 OF 2
CALCULATED BY CHB DATE 6/81
CHECKED BY DLP DATE 11/81
SCALE Naval Station

CROSS-SECTİONAL AREA REMAINING

$$\frac{(12 - (2 - 3.75))^2}{4} + \frac{(12 - (2 - 1))^2}{4}$$

= 9.59 in²

$$\text{ALLOWABLE LOAD} = 9.59 \text{ in}^2 \times 12.6 \text{ ksi} = 121 \text{ or } 60.5 \text{ TONS}$$

Maximum Applied Load

$$550 \text{ psf} \times 120 \text{ sq ft} = 66,000 \text{ lbs or } 33 \text{ TONS}$$

60.5 TONS > 33 TONS % OK

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JOB 438-808 CHARLESTON NAVY BASE, SC

SHEET NO. 1 OF 7
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____

JACKETED PIPE PILE

STEEL THICKNESS MEASUREMENTS

LOCATION: NAVAL STATION

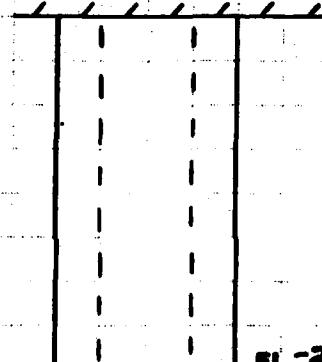
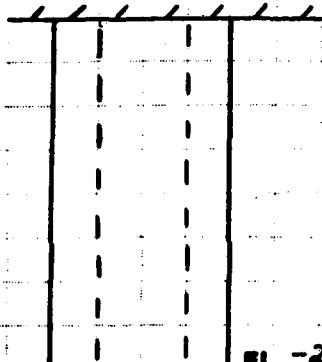
PIER: SIERRA

BENT 5 PILE 2
PILE TYPE 12"Ø PIPE

BENT 10 PILE B
PILE TYPE 12"Ø PIPE

ORIGINAL THICKNESS: .375"

ORIGINAL THICKNESS: .375"



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JOB 438-803 CHARLESTON NAVY BASE, SC

SHEET NO. 2 OF 7
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____

JACKETED PIPE PILE

STEEL THICKNESS MEASUREMENTS

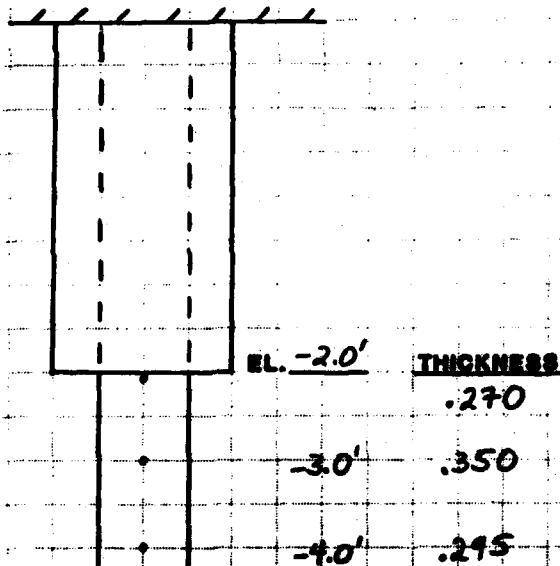
LOCATION: NAVAL STATION

PIER: SIERRA

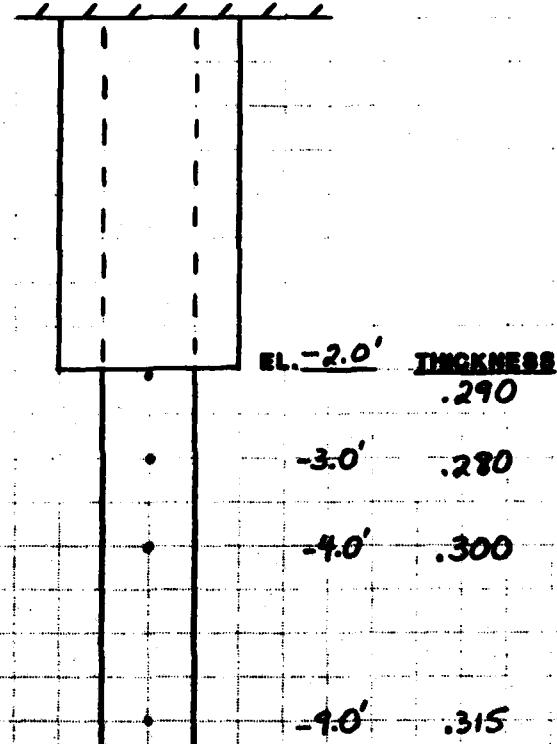
BENT 15 PILE B
PILE TYPE 12" Ø PIPE

BENT 20 PILE A
PILE TYPE 12" Ø PIPE

ORIGINAL THICKNESS: .375"



ORIGINAL THICKNESS: .375"



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JOB 438-80B CHARLESTON NAVY BASE, SC

SHEET NO. 3 OF 7

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

JACKETED PIPE PILE

STEEL THICKNESS MEASUREMENTS

LOCATION: NAVAL STATION

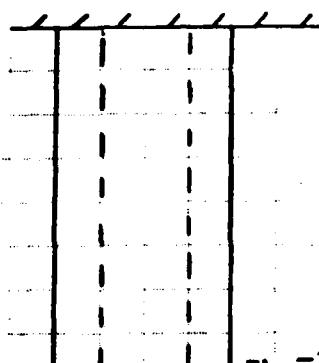
PIER: SIERRA

BENT 25 PILE 1
PILE TYPE 12" Ø PIPE

BENT _____ PILE _____
PILE TYPE _____

ORIGINAL THICKNESS: .376"

ORIGINAL THICKNESS: .376"



EL. -2.0' THICKNESS

.315

• -3.0' .310

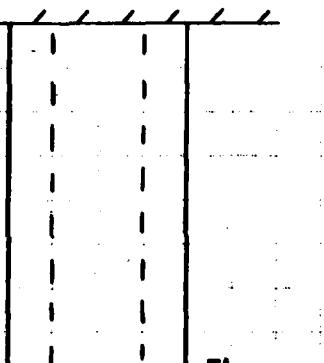
• -4.0' .305

• -7.0' .300

• -14.0' .355

EL. _____ THICKNESS

ORIGINAL THICKNESS: .376"



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JOB 438-80B CHARLESTON NAVY BASE, SC

SHEET NO 4 OF 7

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

JACKETED PIPE PILE

STEEL THICKNESS MEASUREMENTS

LOCATION: NAVAL STATION

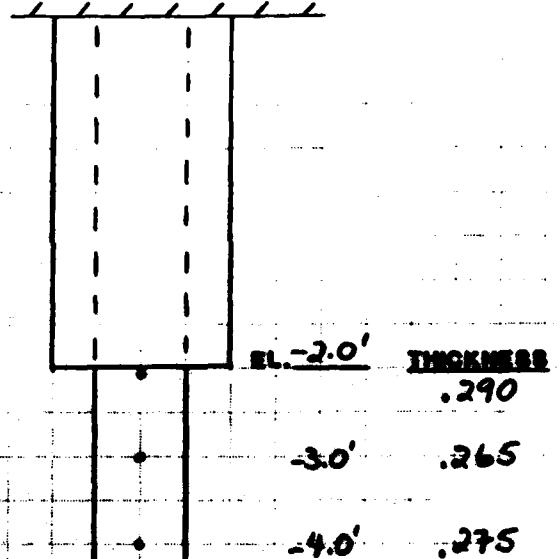
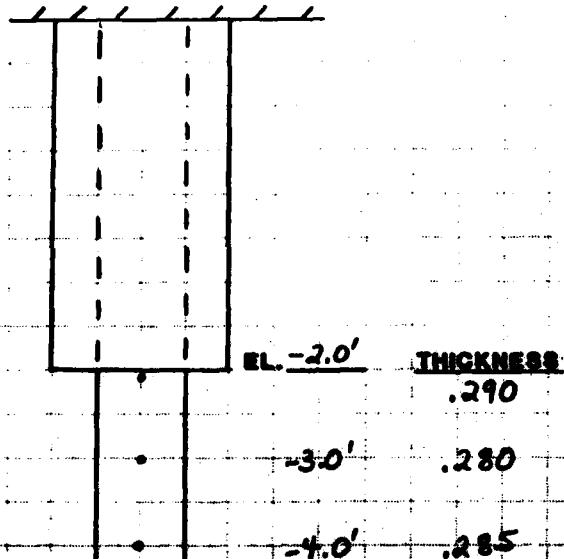
PIER: TANGO

BENT 10 PILE 2
PILE TYPE 12" Ø PIPE

BENT 15 PILE B
PILE TYPE 12" Ø PIPE

ORIGINAL THICKNESS: .375"

ORIGINAL THICKNESS: .375"



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438-808 CHARLESTON NAVY BASE, SC

SHEET NO. 5 OF 7

5 or 7

CALCULATED BY _____ **DATE** _____

DATE

CHECKED BY _____ DATE _____

DATE

SCALE _____

100

JACKETED PIPE PILE

STEEL THICKNESS MEASUREMENTS

LOCATION: NAVAL STATION

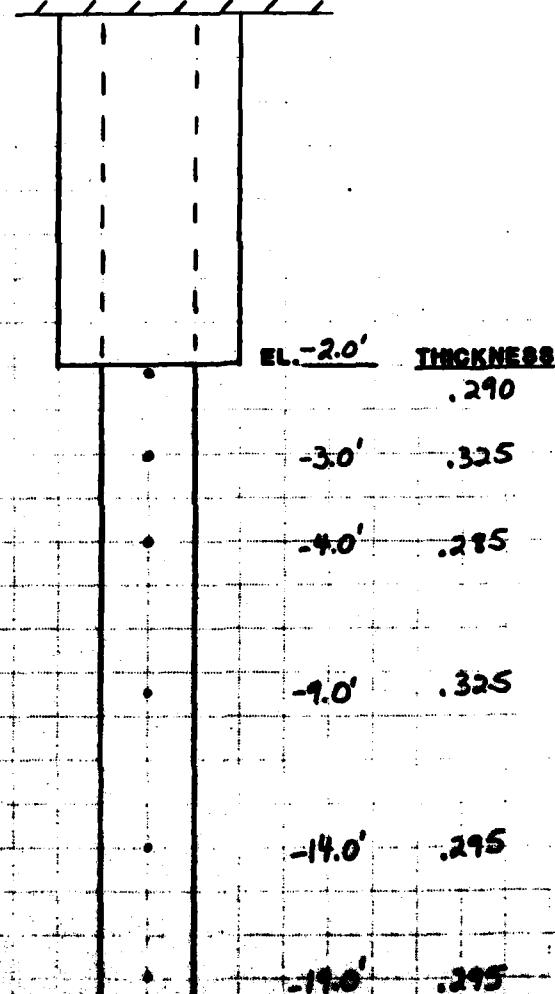
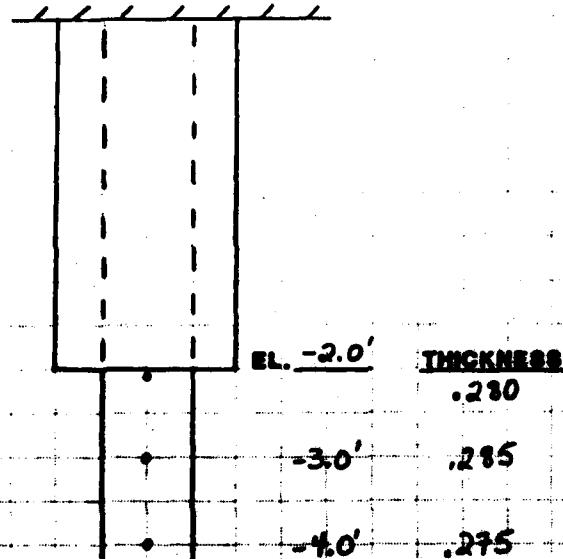
PIER: TANGO

BENT 20 PILE A
PILE TYPE 12"Ø PIPE

BENT 25 PILE 1
PILE TYPE 12"Ø PIPE

ORIGINAL THICKNESS: .375"

ORIGINAL THICKNESS: .375"



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JOB 438-80B CHARLESTON NAVY BASE, SC

SHEET NO. 6 OF 7

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

JACKETED PIPE PILE

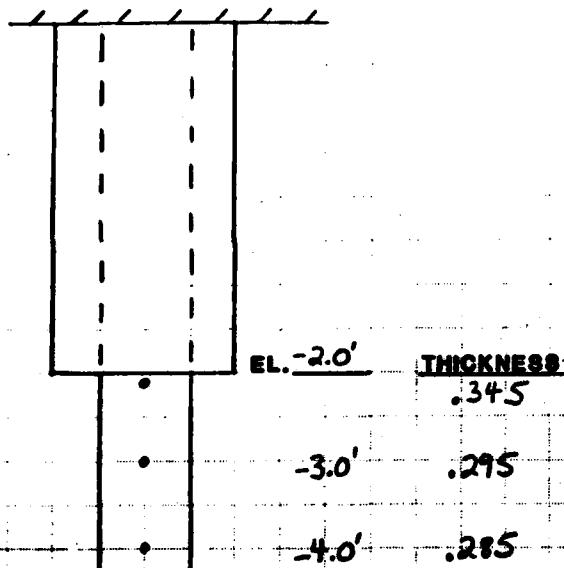
STEEL THICKNESS MEASUREMENTS

LOCATION: NAVAL STATION

PIER: UNIFORM

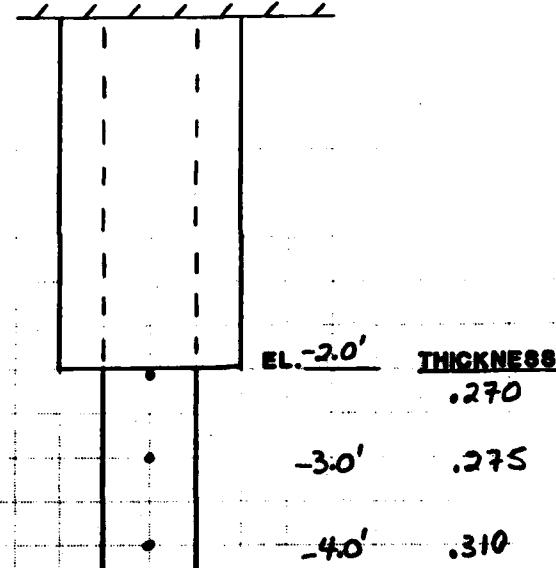
BENT 10 PILE 2
PILE TYPE 12" Ø PIPE

ORIGINAL THICKNESS: .375"



BENT 15 PILE B
PILE TYPE 12" Ø PIPE

ORIGINAL THICKNESS: .375"



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JOB 438-80B CHARLESTON NAVY BASE, SC

SHEET NO 7 OF 7

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

JACKETED PIPE PILE

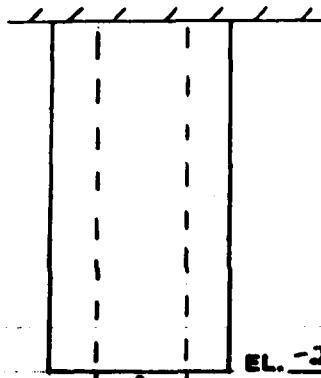
STEEL THICKNESS MEASUREMENTS

LOCATION: NAVAL STATION

PIER: UNIFORM

BENT 20 PILE A
PILE TYPE 12" Ø PIPE

ORIGINAL THICKNESS: .375"



EL. -2.0' THICKNESS
.300

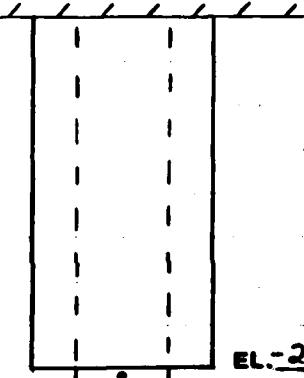
• -3.0' .290

• -4.0' .290

.310

BENT 25 PILE I
PILE TYPE 12" Ø PIPE

ORIGINAL THICKNESS: .375"



EL. -2.0' THICKNESS
.340

• -3.0' .315

• -4.0' .285

.340

DATE
ILMED
-8